POWER PLANT ENGINEERING

GENERATION - TRANSMISSION - DISTRIBUTION - UTILIZATION

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JULY
1935

Vol. XXXIX., No. 7

Published on the first of each month, copyright 1935 by the
Technical Publishing Co., 53 W. Jackson Blvd., Chicago.
New York Office, 171 Madison Ave.

EDITORIAL STAFF: ARTHUR L. RICE, Editor. R. E. TURNER, Managing Editor.
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Subscription price. U. S. A. $2.00 a year; other countries, $3.50 a year. Single copy current issue, 25c; other countries, 35c. January issue, U. S. A., 50c; other countries, 60c. Back issues, single copy, U. S. A., 40c; other countries, 50c. January issue, U. S. A., 75c; other countries, 85c.

Member, Associated Business Papers, Audit Bureau of Circulations.
Circulation of this issue, 19,400

At Thirty Dollars *per* Blade

THESE FEMININE STUDENTS of thermodynamics seem very much interested in the explanation of the operation of this turbine rotor being given them by Mr. Barth of the Allis-Chalmers Co., and why not? He probably has just impressed them with the fact that these blades travel at the tremendous speed of 600 miles per hour and that the material alone in the larger of these blades is valued at over thirty dollars per blade! This, understand, does not take into account the value of the workmanship involved.

A rotor of this kind, therefore, is a rather valuable item in the construction of a large turbine and it is not to be wondered at that extensive and elaborate precautions are taken to prevent damage or destruc tion from excessive vibration or rubbing during operation, especially during the starting period. In the warming up process the shafts of our very largest steam turbines actually undergo an expansion of as much as a half inch and unless this elongation takes place slowly and evenly, serious distortion may result with consequent damage to the rotor if it is brought to speed under these conditions.

For this reason, every possible care is exercised during the starting period. The attendants keep constant watch and are alert to the slightest sign of trouble—noise, vibration, etc. Recently, however, there has been developed a group of electrical instruments which are destined to take the place of the turbine attendant in this respect. For these instruments not only maintain an unfailing watch over the machine for vibration, shaft eccentricity, rubbing of internal parts and expansion, but also provide a continuous record of these quantities. The indicating and recording elements of these supervisory instruments as described on page 384 of this issue are mounted on panels along with the regular turbine instruments.

• • •

Engineering is engineering, regardless of whether it happens to be connected with a privately owned project or a government or municipally owned project. While the politicians and the capitalists are arguing the virtues and shortcomings of public versus private ownership, the engineer, despite the fact that he is continually being criticized for his lack of participation in public affairs, manages to build excellent plants for both sides. From an engineering standpoint there is no difference between a privately owned plant and a federal or municipally owned plant. The engineer gives to both classes of plants the benefits of his skill and experience. In this issue we present a description of the Taunton Municipal Plant, a splendid example of low investment and at the same time an efficient and useful plant. Combining electric generation with a district steam heating system, this new unit, built at a cost of $43 per kilowatt, has a thermal rate as low as 10,000 B.t.u. per kilowatt hour.

• • •

After seeing it or reading about it, one wonders why it has not been done before. We have reference to the Quadrature Oscillograph described on page 406. For many years we have been familiar with the conventional type of revolving mirror oscillograph and have seen it develop to a truly marvelous degree of refinement and excellence. In this issue, however, we present a description of an oscillograph which has no revolving mirror nor cathode ray, yet is extremely effective in its operation and at the same time is simple. The idea no doubt was derived from the cathode ray oscillograph but the manner in which it has been carried out is ingenious. It was developed for use in connection with radio work, but since it is primarily adapted for use on low frequency circuits it should have many uses in the power field. The name of the instrument we admit is entirely too formidable for such a comparatively simple mechanism.

WITH THE EDITORS

To June Graduates and their Elders

IT IS JUNE, and in the schools and colleges and universities throughout the nation, thousands of young men and women will step out upon commencement platforms this month to receive their diplomas. It is a proud moment for these young people for in having successfully completed the required courses of study they have established their intellectual identity and they face the world with all the hope, confidence and ambition that is characteristic of youth. Among these graduates there will be a considerable number with engineering degrees, and it is of these that we wish, particularly, to speak here.

For there has been much discussion of late as to what constitutes or should constitute a proper engineering education and the status of the young engineer graduate is not entirely a happy one at the present moment. He is being launched into a confused and bewildered world—a world unbalanced by the very forces which the engineer controls. It is not that the world is suffering from an overdose of engineering, however, so much as from a sheer inability to adjust itself to the advantages and riches which engineers and scientists have provided. The difficulty lies not in the failure of engineering to serve but in the inability of social and political forces to direct the power of science and engineering to the happiness of mankind. There are many, however, who do not know this, who are ignorant of the fundamental factors in the world's unrest and who lay the blame to engineering and scientific progress, to mechanization. There are those who propose scientific holidays. Others deplore the machine and urge the return to muscular power. Such proposals are of course futile. The progress of mechanical development is inevitable and will continue regardless of anything we attempt to do about it.

The point we wish to emphasize, however, is that the misunderstanding as to the place of the machine in civilization makes it difficult for the young engineer in his outlook on life. Here are these men, and women perhaps, trained in science and engineering, firm in their belief of its benefits, ready to apply their knowledge, turned out into a world which is ruled largely by non-engineering minds and which in some quarters, if not actually hostile, is at least distrustful, of the usefulness of science to humanity. What of their future?

As to their economic future, we need have little apprehension. These young people have been well trained and educated and are capable. If any can hope to survive, they can. Many of them will prosper and rise high in their profession. Their paths may not always be smooth but if any are able to travel it, they are. Indeed, the attainment of material success will be easier than the adherence to the ideals they hold now. It is of this we wish to speak here and in doing so we can do no better than to quote the remarks of President Robert Maynard Hutchins of the University of Chicago in addressing the graduating class there several days ago:

"Believe me," he said, "you are closer to the truth now than you ever will be again. As time passes resist the corruption that must come with it. Take your stand now before time has corrupted you. Courage, temperance, liberality, honor, justice, wisdom, reason and understanding, these are still the virtues. In the intellectual virtues this university has tried to train you. The life you have led here should have helped you toward the rest. If, come what may, you hold them fast, you will do honor to yourselves and to the university and you will serve your country.

"My experience and observation lead me to warn you that the greatest, the most insidious, the most paralyzing danger you will face is the danger of corruption. Time will corrupt you. Your friends, your wives or husbands, your business or professional associates will corrupt you, your social, political and financial ambitions will corrupt you. The worst thing about life is that it is demoralizing."

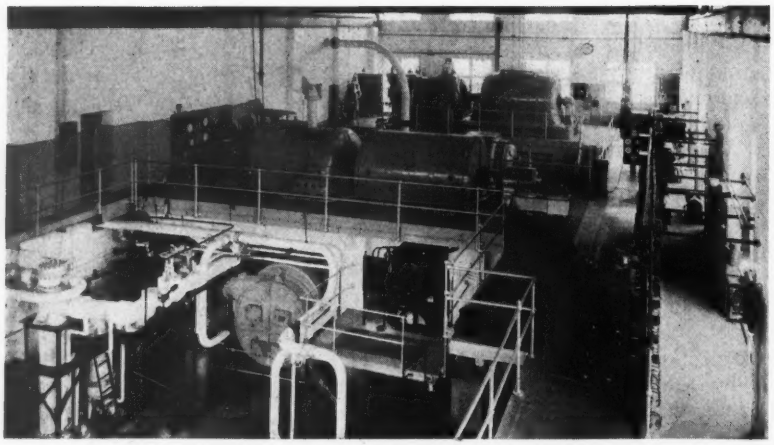
These are words of wisdom, indeed, and though they are addressed to a younger generation, the older generations can heed them to advantage. For it is the older generation that corrupts youth and destroys its ideals. Give youth a chance. Do not seek to impose upon it the distorted philosophy of a world which has made no better showing of itself than it has. The youth of today are in possession of all the accumulated knowledge of all ages past and given a chance they can at least make as much of the world as we have done.

Quiet, Please

NOISE THAT originates in machinery at work does have a most pleasing psychological effect upon workmen in the vicinity, as it is distinct evidence of something being done. Many irrefutable reasons may be given, however, why the common hum, clatter, hiss and crash, which seem to be a part of working machinery, should be entirely eliminated or at least reduced to a point where they are no longer annoying to the nerves of people who must subject themselves to them.

Due, probably, to the fact that noise elimination has not been considered an economic necessity, this problem has been one of the last to be attacked in a practical way by scientists. At present, however, distinct progress is being made through studies being conducted by the American Standards Association to establish a standard for noise instruments. It has been suggested that such instruments will enable comparisons whereby standard levels of quietness can be established just as we have established standard conditions of temperature, humidity and light intensity. This first definite step toward more quiet operation of industrial machinery will find no opposition among power plant engineers.

District Steam Heating *and at the* Taunton



NEW 7500 kw. Extraction type turbo-generator unit together with new 450 lb. pressure boiler supplies steam for district steam heating service. Built at a cost of less than $43.00 per kw., the plant, when supplying both steam and electric service, has a thermal rate as low as 10,000 B.t.u. per kilowatt-hour.

APPROXIMATELY a year and a half ago, in January 1934 to be exact, there was placed in operation at the Taunton Municipal Lighting Plant at Taunton, Massachusetts, a new 7500-kw. turbo generating unit, together with new boiler equipment and auxiliaries, designed for operation at 450 lb. pressure and 725 deg. F. The installation of this equipment attracted widespread attention, principally because of the extremely low investment cost involved, an investment of less than $43 per kilowatt.[1]

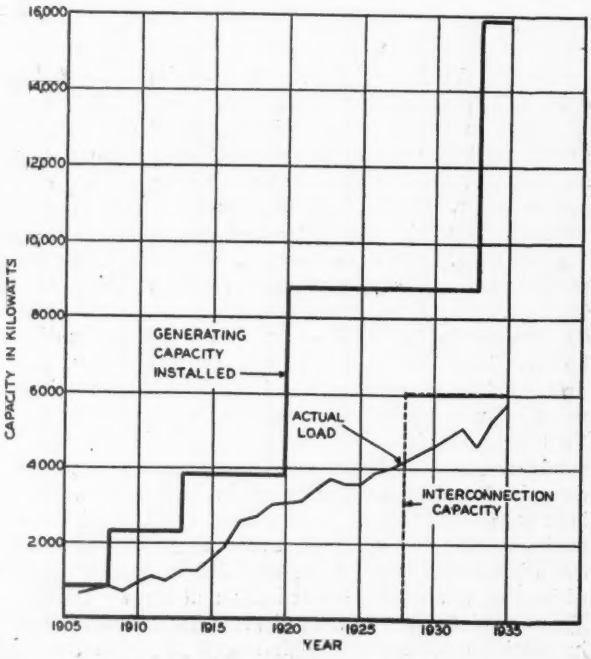


Fig. 1. Capacity schedule and load curve

This low investment cost, however, was only one of several features which make this station important. From an operating standpoint its high efficiency and its successful co-ordination with a central heating system are features of equal, if not of greater, interest than its low investment cost.

The entry of the Taunton Municipal Lighting Plant into the field of district steam service marks the final step in the program of extension of the generating facilities and modernization of the plant. It is the final result of a study started about three years ago, to achieve more economical production of energy for the system, combined with the sale of steam and electric manufacturing plants in Taunton.

With respect to distribution, particularly as regards steam, the Taunton plant is favorably situated. It is located on the Taunton River in the south industrial district of the city in proximity to 14 large industrial and manufacturing plants which have large requirements for steam for building heating and process work. These manufacturing concerns are present electric customers.

Immediately following the installation of the new generator in January 1934, work was begun on the underground steam distribution system and continued throughout the year. It was completed and placed in service on September 15, 1934. The total amount of pipe installed was approximately 8000 ft. including service connections.

Before we describe the details of the heating system, it will be of interest to know something about

[1]Power Plant Engineering, December 1934, pp. 558, 566.

Electric Service *Combined* Municipal Plant

the history of the plant, its growth and the methods employed in its management and system of financing. The plant dates back to 1902 when it went into operation with an 800-kw. reciprocating engine generating unit operating at 150 lb. steam pressure and delivering alternating current at 2300 v.

In 1908 a 1500-kw. vertical turbine unit was added, and in 1914 a 1500-kw. horizontal turbo-generator was installed. By 1920 the load had increased to something over 3000 kw. and anticipating a steady future increase, a 5000-kw. turbine unit was added in 1921. This new unit operated at 200 lb. pressure so at that time the 1500-kw. horizontal unit was also changed to operate at 200 lb. Previously this machine had operated at 150 lb. The addition of the 5000-kw. turbine brought the station capacity up to 8800 kw., but the load was carried mostly by the last two machines installed since the others were relatively inefficient. As the load still increased in 1928 an interconnection was made with the Montaup Electric Co. and the New England Power Association systems. Finally, in 1933, after a long and thorough survey by the management and Arthur L. Nelson, Consulting Engineer of Boston, the Commission authorized the further expansion of the generating facilities, and with Arthur L. Nelson as consulting engineer on the project the new 7500-kw. 450-lb. turbine unit was added. At the same time the Commission decided to enter the district steam service business. The story of the plant's growth is shown graphically in Fig. 1.

So much for its history. The plant is owned by the city and is managed by a commission appointed by the mayor and which is in complete control of the property independent of the rest of the city government. In general, the members of the commission have been engaged as executives operating successful businesses in Taunton. Chester F. Buckley, the general manager of the municipal lighting department, is a graduate of the Massachusetts Institute of Technology and was formerly with the Brooklyn Edison Co.

Financially, the development is in excellent condition. The commission has avoided building up a heavy funded debt and the property is practically free of obligations. No bonds have been issued since 1926. The additions financed by bonds issued on the city's credit have borne interest varying from 3½ to 4¾ per cent. As a whole, the Taunton system has cost about $3,000,000 with the only outstanding securities totaling $360,000 in bonds and there is a cash surplus of over $400,000.

The New Installation

A cross section of the new boiler and turbine installation is shown in Fig. 3. The boiler is a B. & W. Stirling type unit, having 10,293 sq. ft. of heating surface. In the selection of the boiler, the existing building conditions had to be taken into consideration. A relatively high boiler without excessive width was required and the unit selected was well adapted to these requirements. It is designed for a working pressure of 500 lb. and has fusion welded drums, specially approved by the Massachusetts Department of Public

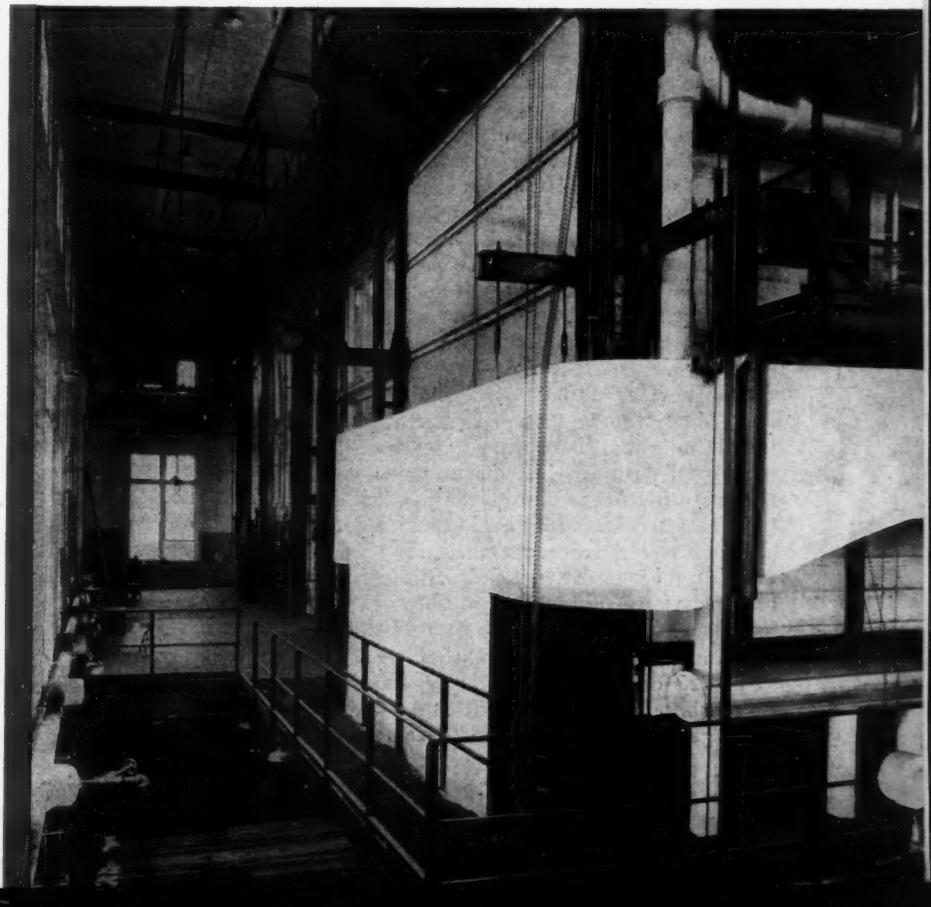


Fig. 2. View showing the new 450 lb. pressure boiler at the Taunton Plant

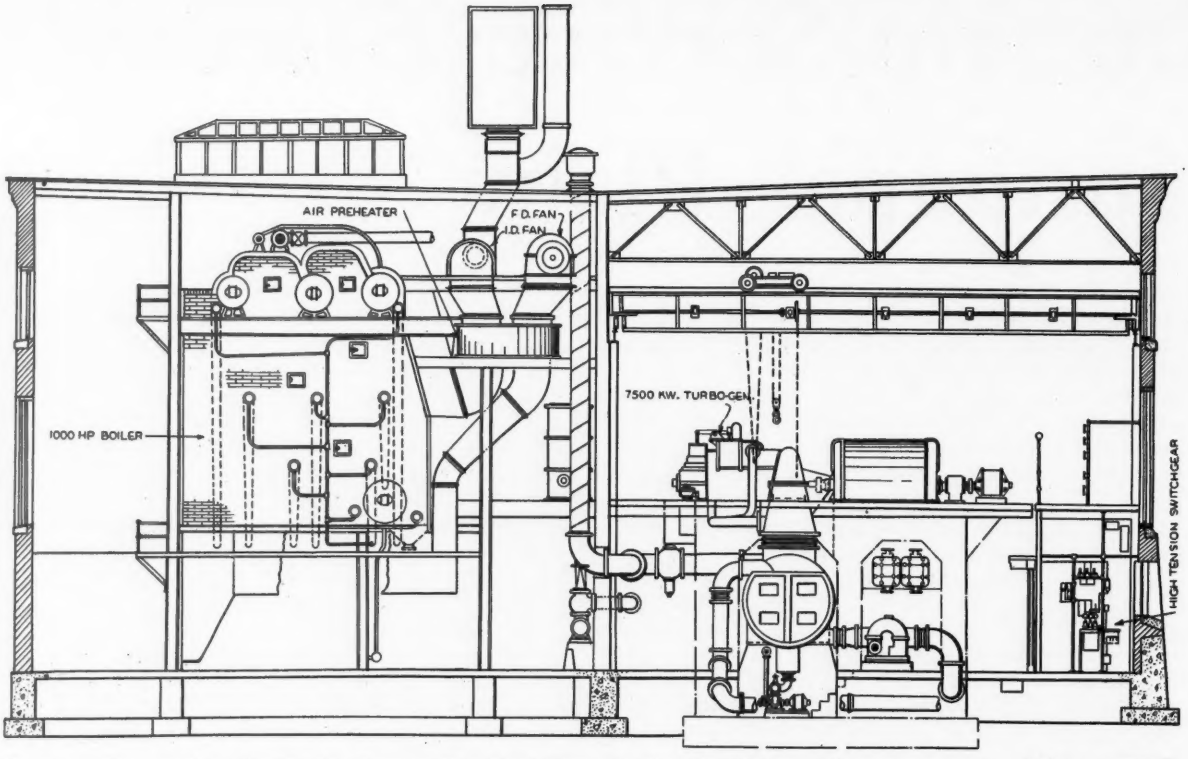


Fig. 3. Cross section through the Taunton Municipal Plant showing the 7500-kw. turbo-generator unit and the new 450 lb. pressure boiler

Safety. This is the first central station boiler in Massachusetts to be equipped with fusion welded drums.

Three of the old boilers are also in service for the 200 lb. turbines. Interconnection between the two systems is provided by reducing valves, so that the old machines may be supplied from the new boiler.

All boilers are oil fired. The new unit, however, is provided with burners using mechanical atomization while the old boilers use steam atomization. In consequence of this, there are two fuel oil systems and two sets of oil pumps. Fuel oil is stored in 3 tanks, totaling 1,000,000 gal., but the oil pumps draw the oil from two 25,000 gal. utility tanks. The fuel oil systems operate on return line pressure, that is, the pressure on the burners is regulated by closing or opening the return line to the pump. The pressure of the supply line is maintained around 210 lb. On the mechanical atomizing system the oil temperature is kept at 170 deg.; on the steam atomizing system the temperature is 130 deg.

The new boiler is provided with both forced and induced draft and an air preheater of 9980 sq. ft. heats the air to a final temperature of 440 deg.

A well designed instrument panel is provided on the operating floor opposite the new boiler. This contains steam pressure indicating and recording meters, a boiler meter, recording thermometers, draft gages and CO_2 recorder as well as instruments used to check the feed water treatment.

The new turbo-generator is a 7500-kw., 9375-kv-a. Westinghouse machine designed for 425 lb. gage pressure, 725 deg. F., total temperature and generates three phase, 60 cycle current at 13,000 v. The older units generate at 2300 v. and feeders deliver current at this potential to many local customers. A 5000-kv-a. transformer bank ties the 2300 v. and the 13,000 v. busses together and a 13,000-v. a.c. network delivery energy to various substations and large customers on the system. A diagram of the present electrical system is shown in Fig. 5. As will be noted there are two busses, a main bus and an emergency bus. The high voltage feeders, it will be noted, are installed with circuit breakers and disconnecting switches permitting operation on either of the two 13,000-v. buses.

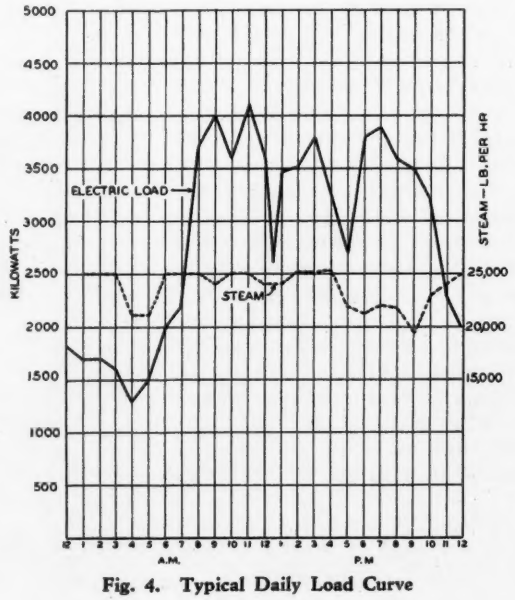


Fig. 4. Typical Daily Load Curve

The turbine, which exhausts into a surface condenser operating at 29 in. vacuum, is a single cylinder, single flow unit of the combination impulse and reaction type. It is provided with a seven valve steam chest mounted on the cylinder cover equipped with plug valves operated by a lifting bar connected to the governor mechanism, the latter being mounted on the thrust pedestal. The turbine rotor is a single forging of 3½ per cent nickel steel and the cylinder, consisting of base and cover, is provided with a water catcher groove in the space ahead of the last stationary blade row to remove part of the moisture that would otherwise pass through the last moving row with severe erosive effect on the blades. This device was tested in the shops of the manufacturer before the unit was shipped and was found to be highly effective in removing moisture from the steam.

The most important feature of this generating unit is the fact that it is arranged to supply extraction steam to the central heating system. Steam is extracted from one of the intermediate stages of the turbine and fed to the 200 lb. high pressure steam main through a reducing valve. Steam for the heating system of

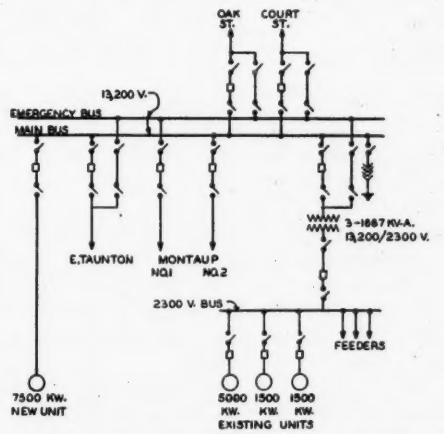


Fig. 5. Single line wiring diagram showing connections between the old and the new units

course can also be supplied from the old boilers. The amount of steam extracted for this purpose varies throughout the hours of the day but over a period of 24 hr. it amounts to approximately 50 per cent of the total amount of steam generated. The operating data for a typical February day is shown below. Out

Plant Data for a Typical Day in February. Operating with Steam Distribution System

	12 p.m. 8 a.m.	8 a.m. 4 p.m.	4 p.m. 12 p.m.	24 hours
Kw-hr. output	13,000	29,000	24,000	66,000
Steam—Elec. Gen.	164,944	309,082	276,888	750,914
Steam—Distrib. System	224,211	203,652	192,044	619,907
Total Steam Generated	389,155	512,734	468,932	1,370,821
Oil Consumed—lb.	31,898	35,119	33,736	100,753
Lb. steam per lb. oil	12.2	14.6	13.9	13.4
Lb. oil per Kw-hr.	1.04	0.73	0.83	0.845

of a total of 1,370,821 lb. of steam generated during the 24 hrs., 619,907 lb., it will be seen, is credited to the steam distribution system. On a full condensing cycle the plant operates on a basis of 15,000 to 16,000 B.t.u. per kw-hr. but when bleeding about 50 per cent

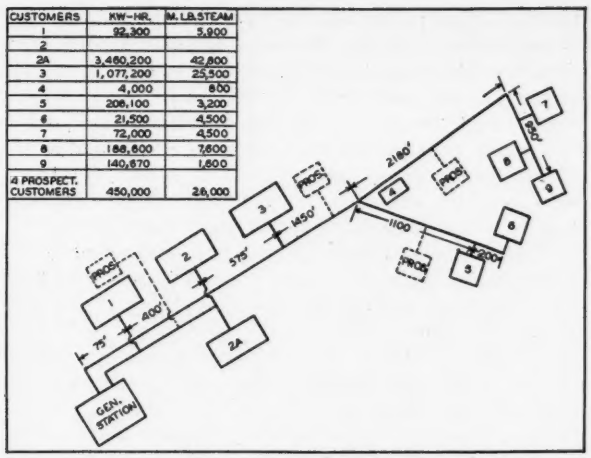


Fig. 6. Diagram of the steam distribution system

of the steam to the heating system, a heat rate of around 10,000 B.t.u. per kw-hr. is attained.

The new turbine is installed in the space formerly occupied by the reciprocating engine, approximately in the center of the turbine room. The 8500 sq. ft. surface condenser is installed directly below, easily accessible and with short and direct piping to the auxiliaries. It is served with a dual driven 7000 g.p.m. circulating water pump, one motor driven 160 g.p.m. condensate pump, one steam driven 160 g.p.m. condensate pump and a two stage twin air ejector unit mounted on common inter and after coolers. The vertical extraction heaters are mounted along the wall, close to the condenser as may be seen in the accompanying photograph of the turbine room. The turbine room, as will be noted, is attractive in appearance. With the walls and ceiling painted white, and large windows on three sides, the room is unusually light. An interesting feature of the turbine room are the unit heaters installed to provide adequate heat during the winter months.

In addition to the steam extracted for the steam heating system, steam is also extracted for feed water heating. Two extraction heaters are provided for this purpose, one low pressure unit of 160 sq. ft. of heating surface and a high pressure unit of 320 sq. ft. These are of the vertical type and are installed in the turbine room on the condenser floor. Condensate is delivered by the hot-well pumps which are installed in duplicate, first to the generator air cooler. From the air cooler

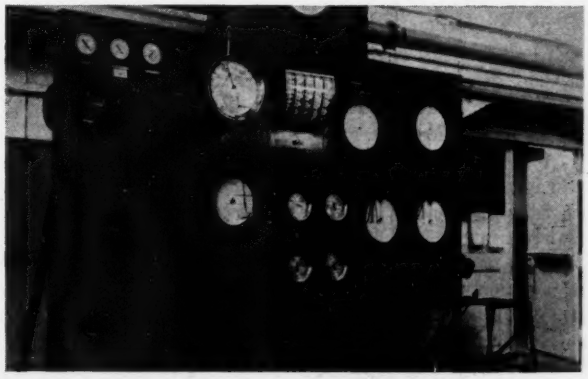


Fig. 7. Boiler Instrument Board

the condensate passes successively through the turbine oil coolers and the air ejector condenser to the low pressure extraction heater. Next it is sent to a deaerating heater and finally to the boiler feed pumps and the high pressure extraction heaters to the boiler. Two boiler feed pumps are provided, each capable of delivering 225 g.p.m. under a 1500 ft. head. The temperature of the water leaving the high pressure extraction heaters averages about 270 deg.

With the plant operating on a full condensing cycle the make up required is only about two per cent but under ordinary conditions when supplying steam for heating, the make up water required is about 40 per cent. The feed water is well water which is treated by Hall system equipment. Provision is made also for operating the plant on city water in times of emergency. Water is delivered into a storage tank in the upper part of the boiler room from which it drains into the deaerating heater. The steam driven turbine auxiliaries are operated from the 200 lb. steam main.

The steam distribution system is fed either from the old boilers or from the turbine extraction line. The total amount of pipe installed in the system is approximately 8000 ft. including service connections. This pipe varies in size from ten inch down to four inch. The system was designed and built for operation up to 200 lb. pressure. Welded construction was used throughout. The distribution line was covered with 2½ inches of thermal insulation. The slip type joint located in manholes approximately 450 feet apart was used. On account of the straight runs and uniform grade it was possible to use the slip type of joint generally throughout. At only two points were sump manholes necessary and reinforced concrete envelope of standard design for heavy traffic was used to house the pipe line.

A diagram of the steam heating system together with data on the amounts of steam and electricity used by the customers is shown in Fig. 6. Before the line went into operation last September approximately 78 per cent of the total available business was signed up. The rate at which this steam is sold to customers is as follows:

First 10,000 lb. of steam per mo., $2.00 per M. lb.
Next 90,000 lb. of steam per mo., $1.00 per M. lb.
Next 100,000 lb. of steam per mo., $0.75 per M. lb.
Next 800,000 lb. of steam per mo., $0.50 per M. lb.
All over 1,000,000 lb. of steam per mo., $0.40 per M. lb.

Only two of the remaining possible customers have small sections of their plants not completely motorized. It is expected that the availability of the steam and electric service will increase the development in this industrial area.

For emergency lighting of the station, a 64 cell storage battery is provided. This cuts in automatically on four or five of the most important lights in the station when the power fails. The remaining lights can then be transferred to the storage battery manually, if necessary.

The electric rates have been maintained as low as possible and frequent rate reductions have contributed to the upbuilding of the system through increased business encouraged by lower prices. The highest step in the residential service rate is now 6 cents per kilowatt hour which is the rate for the first 30 kilowatt hours per month. This is followed by a rate of 4 cents for the next 70 kilowatt hours, 2½ cents for the next 150 kilowatt hours and finally 1½ cents for all power over 250 kilowatt hours.

As was stated at the beginning of this article, this new installation was made at a cost of less than 43 dollars per kilowatt. Complete cost figures are as follows:

	Total Cost	Cost per kw.
a. Clearing site	$ 4,600.00	$0.61
b. Building and foundation	31,400.00	4.18
c. Boiler	47,500.00	6.34
d. Fuel burning equipment	7,500.00	1.00
e. Draft system	9,700.00	1.29
f. Feed-water system	12,600.00	1.68
g. Feedwater treating plant	1,700.00	0.23
h. Miscellaneous pumps, tanks, etc.	600.00	0.08
i. Boiler room instruments, controls	7,800.00	1.04
j. Piping	35,300.00	4.71
k. Turbine-generator and aux.	152,000.00	20.25
l. Wiring and switching	9,300.00	1.24
Totals	$320,000.00	$42.65

This total cost of $320,000 was $75,000 less than the original estimated cost, which was $395,000. At the time the engineering survey preliminary to the installation of this new unit was made, an attractive proposal for additional purchased capacity was made by the local public service company but a comparison between purchased and installed capacity showed in favor of the installation of the new unit. The low cost of installation and the efficiency obtainable in combined electric and steam generation had a very important bearing on the result.

In concluding this description we express our appreciation to Chester F. Buckley, manager of the Taunton Municipal Lighting Plant, for his many courtesies and valuable assistance in preparing the data on which this article is based, and also to Arthur L. Nelson, the Consulting Engineers, for data furnished.

Principal Equipment Taunton Generating Plant Addition

Owners—City of Taunton, Mass.
Location—Taunton, Mass.
Service—Electric Power and Steam Heating.
Consulting Engineers—Arthur L. Nelson.

Boiler and Auxiliaries

Boiler—One, Stirling type 10,293 sq. ft. heating surface, 500 lb. working pressure, fusion welded drums, Babcock & Wilcox Co.

Superheater—One final temperature 725 deg. F. pendant loop type, Babcock & Wilcox Co.

Soot Blowers—Six elements, Diamond Power Specialty Corp.

Blow-off Valves—Babcock & Wilcox Co.

Forced Draft Fan—One, 28,000 c.f.m. against 8-in. static head driven by Sturtevant turbine and gear, B. F. Sturtevant Co.

Induced Draft Fan—One, 48,000 c.f.m. against 4-in. static head driven by Sturtevant turbine and gear, B. F. Sturtevant Co.

Air Preheater—One, 9,980 sq. ft. Ljungstrom air heater, final temperature 440 deg. F., Air Preheater Corp.

Oil Burners—Four, mechanical type, Peabody Engineering Corp.
Breeching and Ducts—Jennison Co.
Combustion Control—The Hays Corporation.
Reducing Valves and Desuperheaters—Two, one 6-in., one 2-in. with common control, Hagan Corporation.

Turbine Generator and Auxiliaries

Turbine Generator—One, 7500-kw., 9375 kv.a., 13,800-v., 3-ph., 60-cycle generator with 45-kw., 125-v. shaft exciter driven by 7500-kw., 3600 r.p.m. turbine designed for 425-lb. gage throttle pressure, 725 deg. F. total temperature, Westinghouse Electric & Mfg. Co.
Generator Air Cooler—One, 3670 sq. ft., two section, Westinghouse Electric & Mfg. Co.
Generator Oil Cooler—Westinghouse Electric & Mfg. Co.
Surface Condenser—One, 8500 sq. ft., two-pass with dual-driven 7000 g.p.m. circulating water pump, one motor driven 160 g.p.m. condensate pump, one steam-driven 160 g.p.m. condensate pump and two-stage twin air ejector unit mounted on common inter and after coolers, Westinghouse Electric & Mfg. Co.

Feed Water Equipment

Extraction Heaters—Two; one low-pressure, 160 sq. ft., one high-pressure, 320 sq. ft. vertical type, Westinghouse Electric & Mfg. Co.
Deaerating Heater—One, 100,000 lb. per hr. capacity, cast-iron shell, Elliott Co.
Back Pressure Regulator on Heater—Atwood & Morrill.
Feedwater Pumps—Two, 225 g.p.m., 1500 ft. head, four-stage, 3550 r.p.m., one turbine driven, one motor driven, Warren Steam Pump Co.
Control Valves—Three, pump control and boiler water regulator, The Swartwout Co.
Feed Water Treating System—Hall Laboratories.

Steam Distribution System

Station Reducing Valves and Desuperheaters—The Swartwout Co.
Steam Flow Meters—The Foxboro Co., Bailey Meter Co.
Underground Conduits—Charles T. Alger, Inc.
Underground Steam Line—Underground Steam Construction Co.
Expansion Joints—Ross Heater & Mfg. Co., E. B. Badger & Sons Co.
Customers Reducing Valves—Squires Co.
Thermal Insulation—Standard Asbestos Covering Co.

Piping Valves and Fittings

Valves—The Lunkenheimer Co., Chapman Valve Manufacturing Co.
Fittings—Pittsburgh Piping & Equipment Co.
Non-return Valves—The Edward Valve & Mfg. Co.
Fabricated Piping—Lumsden & Van Stone Co.

Instruments

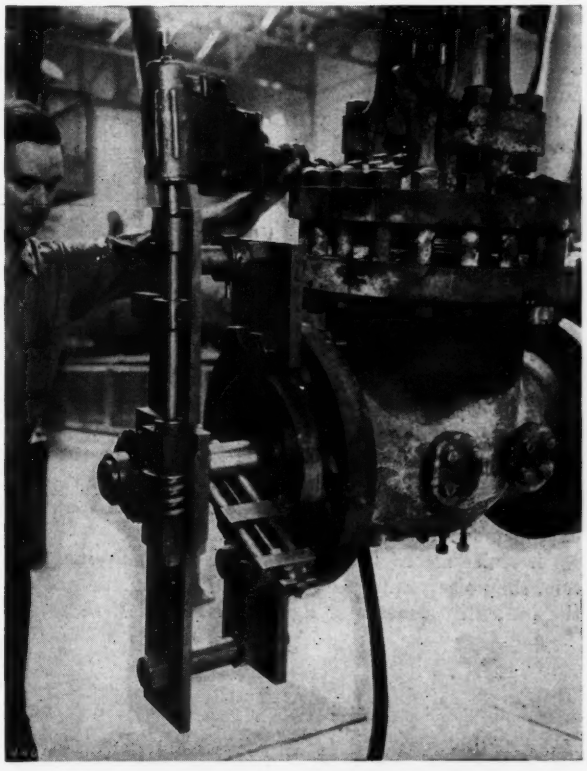
Recording Thermometers—The Foxboro Co., Inc.
Indicating Thermometers—Moeller Instrument Co.
Steam Flow Meters—Bailey Meter Co.
CO_2 Recorder—Republic Flow Meters Co.
Draft Gages—Paul B. Huyette Co., Inc.
Pressure Gages—Crosby Steam Gage & Valve Co.

Wage, Hours and Price Maintenance

SPITE OF the collapse of N.R.A. control, the intent of most industrial leaders as expressed in their posted notices to employes and in replies to questions sent out by the Committee on Business Economics of the Associated Business Papers, Inc., is to maintain the present schedule of hours, wages, abolishment of child labor and, so far as possible prices. Constructive leadership, voluntary agreements and conduct of business so as to induce the greatest and most rapid recovery are seemingly to be the procedure to retain the good that N.R.A. has accomplished and to go forward without the fear of introduction of hampering restrictions and imposition of heavy enforcement expense.

Valve Refacing Tool

VALVE MAINTENANCE in modern high pressure steam plants is a matter of some importance and has furnished subject matter for considerable investigation in the power plant field. Three engineers of the Columbia Park Station, of the Union Gas & Electric Co., Cincinnati, O., have developed a portable machining tool which has been instrumental in reducing maintenance cost at that plant. This tool, shown by the accompanying photograph, was developed, constructed and patented by Pearl T. Heady, test engineer, Edward Murray, master mechanic, and Frank P. Corrigan, assistant chief engineer and may be used for reseating or refacing the valve. In the former case the reseating and grinding can be done without removing the valve from the line. Power is supplied by a small portable air motor and the entire tool is bolted direct to the flange of the valve. Direct centering equipment, and means for shifting the tool is provided for as shown by the photograph.



NEVER LEAVE soldering irons or other electric heating devices on or near inflammable material while they are connected to the electric power supply circuit.

Supervisory Instruments f

Newly Developed Electrical Instruments indicate and record vibration, shaft eccentricity, cylinder expansion and noise on large turbines. They reduce hazards resulting from human fallibility.

MARKING a noteworthy advance in the direction of automatic turbine operation, electro-magnetic instruments to indicate and record such turbine characteristics as vibration, spindle eccentricity, and cylinder expansion, supplemented with a noise meter, will be one of the features of a large central station turbine now being erected. The development of this equipment was started at a time when outdoor steam turbines, automatically operated, were actively discussed as a possibility of reducing the cost of power stations. The equipment, however, affords a potential means of increasing the operating efficiency by giving accurate records of turbine characteristics.

The equipment ready for installation consists of the following groups:

1. Eccentricity meters to indicate and record the shaft eccentricity of the high pressure and low pressure spindles at a point between the oil ring and the gland case.

2. Vibrometers to indicate and record the range of vibration in the vertical and horizontal directions at one turbine and one generator bearing.

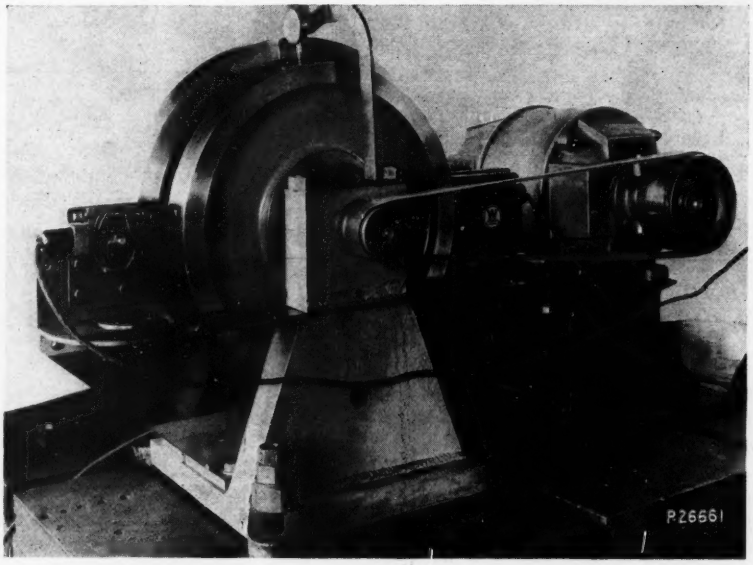
3. Expansion meter to indicate and record the axial expansion of the turbine cylinder.

4. Noise meter to indicate through an amplifier system, the noise produced by the blading and the glands, the indicatiing meter being supplemented with a pair of head phones to provide an audible signal.

These meters will allow a quantitative measure of the various factors determining the safety of starting and operating the turbine. The indicating and recording instruments will be located in a group on the turbine room gage board, making it possible to observe these various factors simultaneously at one central location.

This equipment will be particularly serviceable during the starting period when it is necessary to ensure having the spindle straight before bringing up to speed and to guard against mechanical contacts.

During the shutdown period the bottom section of a turbine tends to cool faster than the top, and as a result may become slightly bowed. When the machine is started up again the shaft will run eccentrically. On large turbines the effects of this uneven cooling is reduced by rolling the spindle by means of an external turning gear for some time after it has



THREE TYPES OF SUPERVISORY INSTRUMENTS FOR STEAM TURBINES

Fig. 1. The eccentricity detector set up for test and calibration. Diameter of the disk corresponds to the diameter of the turbine shaft

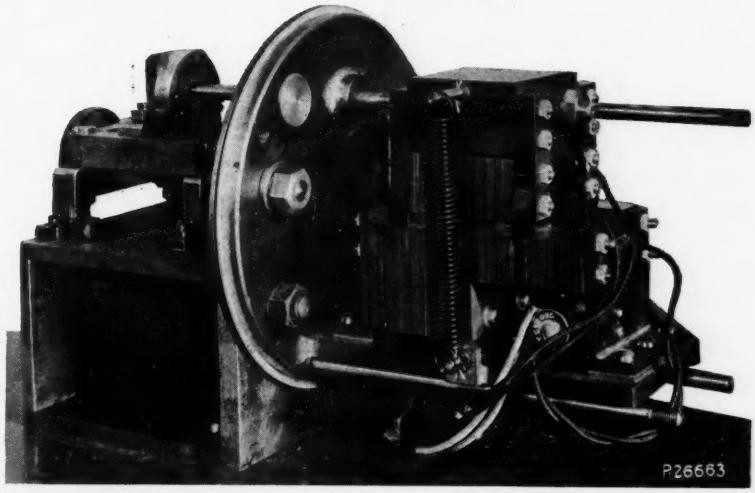
Fig. 2. Vibration detectors on test. Eccentric load on motor shaft serves as a source of vibration for flexibly supported table. Assembled expansion detector is shown to the left

Fig. 3. Upper right. Expansion detector shown with case removed to show mechanism

ts for Steam Turbines

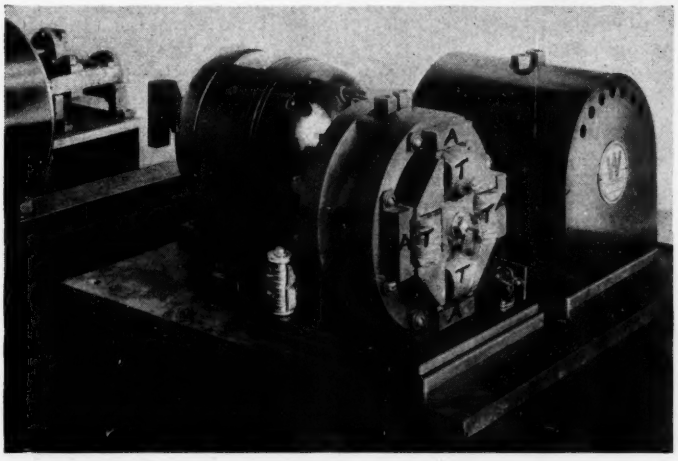
By H. STEEN-JOHNSON

Turbine Division
Westinghouse Electric & Mfg. Co.



been shut down, and at times also before it is started up again.

On starting a turbine it is customary to roll it at slow speed by passing a small amount of steam through the unit. This small steam flow ensures a gradual heating of the cylinder and spindle. The heating and rolling will straighten the



rotor shaft, if it is bent, and bringing the temperature of the spindle and cylinder up slowly in this manner insures equal expansion of these parts. If the heating is too rapid the spindle will heat faster than the cylinder, and differential expansion may cause mechanical contact in the close clearances in the blade and gland sealing elements. If the spindle is brought up to operating speed before it has straightened out, there will be excessive vibration. The importance of uniform heating of these parts is due to the magnitude of the axial expansion which on large high temperature turbines is from one-half to one and a half inches.

During the heating period the eccentricity meter will indicate and record the amount of bending in the shaft, and thus serve as an accurate guide in determining when the speed may be increased. At the same time the expansion meter will show the progress of the heating of the cylinder, and indicate whether it is expanding freely and at a uniform rate.

During the heating period the noise meter will detect any mechanical contact in the machine. This instrument will indicate a rub as soon as it occurs, and will also show its approximate location.

The vibrometers give instantaneous readings and permanent records of the vibration at the bearings. When the unit is coming up to speed, they will accurately show whether the machine is in proper balanced condition and thus ensure against increasing the speed too rapidly. This instrument will also be of value during normal operation, since vibration is a common symptom of troubles, which if not detected and checked in time, may jeopardize the safety of the turbine.

The indicating and recording instruments on the gage board are standard electrical instruments, altered in detail to make them more suitable for the application.

The detectors on the turbine, on the other hand, represent some interesting new ideas and designs, some of which were outlined in an article in the technical press about two years ago.

In the vibrometer and eccentricity meter, a measuring principle used for some time by the Westinghouse Co. for measuring small distances has been adapted to a new application. The same principle is applied to the expansion meter in a slightly modified form to take in the greater displacements. The principle consists of introducing the distance to be measured as a variation in the length of an air gap controlling the reactance of an inductive circuit. The inductive circuit is excited from an a.c. source of suitable frequency, and by special coupling of the circuit, its electrical characteristic is a linear function

of the length of the airgap. It is an outstanding feature of the equipment designed on this principle that it avoids mechanical contact between moving parts.

In Figure 4, the eccentricity meter is shown diagrammatically. The detector on the turbine is located between the oil ring and the gland case, and consists of two iron core transformers, T_1 and T_2, mounted as indicated on opposite sides of the shaft. The transformers are identical, and the magnetic circuit for each is made up of the laminated iron core, the airgap between the transformer pole face and the shaft, and a portion of the shaft. The primary windings are connected in series and excited from a constant voltage a.c. source of suitable frequency, while the secondary windings are connected so that the voltages induced will oppose each other and the voltage at the terminals E-E will be the secondary differential voltage. With this arrangement, there will be equal voltage drops over each of the primary windings, equal voltages induced in each of the secondary windings, and zero voltage at E-E when the airgaps are equal. If the airgaps are not equal, the secondary differential voltage will be a linear function of the difference between the air gaps.

When the shaft has a deflection it will run eccentric between the two transformers, and each airgap will go through a complete cycle of change with a maximum and a minimum value in each revolution. The voltage at the terminals E-E will follow the changes in the airgap, and we get at this point the a.c. voltage wave shown by the oscillogram in Fig. 5. By the use of a copper oxide rectifier, the unidirectional voltage wave in Fig. 2 is obtained, and is used to actuate the indicating meter and the recorder.

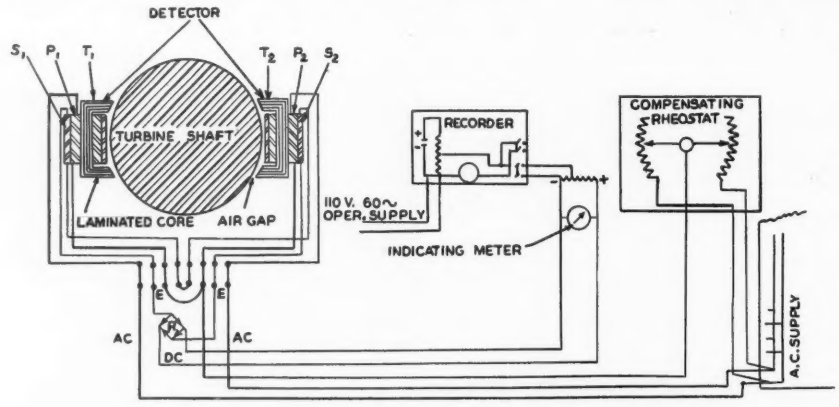


Fig. 4. Diagram showing the elements of the electric eccentricity meter

The movement in the indicating meter and the galvanometer in the recorder are of special construction to give a steady reading on the unidirectional voltage wave for speeds as low as 170 r.p.m. which is well below the normal heating speed of 200 r.p.m. When the machine is turning slower than this, the pointer will partly follow the wave and the eccentricity reading should be taken at the midpoint of the swing of the pointer. When the machine is on the turning gear, the pointer will follow the wave closely and swing from zero to a maximum twice for each revolution.

The recorder used is a potentiometer recorder, of the multipoint type, changing automatically from one detector circuit to another.

Figure 1 shows an eccentricity detector mounted for testing and calibration. Each detector unit is about 5 in. square and 2½ in. thick. The left hand unit has the cover removed, and shows the arrangement of the transformer, and the provisions for adjusting the airgaps to be equal by means of a differential screw. To secure parallel motion, the transformer support is guided in a V-groove. The disc taking the place of the shaft has an offset center disc, allowing an adjustable amount of eccentricity.

The vibrometer is based on the same measuring principle as the eccentricity meter, and in each vibrometer there is one measuring circuit for horizontal vibration, and one for vertical vibration.

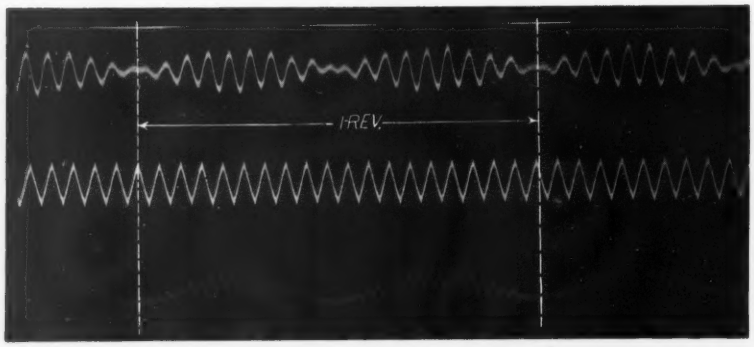


Fig. 5. Typical Oscillographic Record of Eccentricity Meter. Top. Secondary A.C. voltage at EE (see Fig. 1). Center. Primary A.C. Voltage. Lower. Secondary Voltage Rectifier.

Figure 2 shows two vibration detectors mounted for testing. One unit is shown complete with cover, while the other is shown with the cover removed. The overall dimensions are approximately 7 by 7 by 7 in., and the instrument is conveniently located on the

bearing cover. The mechanical design is similar to an amplitude meter built on the seismic principle. The weight "W", which includes the transformers "T", is supported flexibly by a cantilever beam, having equal flexibility in the vertical and horizontal directions. The airgaps are formed between the transformer cores and the laminated pole shoes "A", which are rigidly attached to the case. When vibrations are set up in the bearing pedestal supporting the case, the pole shoes will follow the vibration, while the flexibly supported transformers will remain fixed, due to the inertia of the weight. There will thus be a relative motion between the transformers and the pole shoes, varying the length of the airgaps by an amount equal to the range of the vibration. The two vertical and the two horizontal transformers are connected so that each pair forms an independent measuring circuit, and the instrument will give simultaneous readings of horizontal and vertical vibration.

The expansion meter measures the movement of the sliding pedestal, and is based on a modification of the same measuring principle suited to this particular instrument. The detector, which is to be mounted on the pedestal base, is shown with the cover removed in Fig. 3. The primary coil "P" is attached to the pedestal and rides on the statonary laminated armature "A". The section "S" of this armature serves as core for the secondary windings, and thus as the sliding pedestal moves the primary from left to right, the voltage induced in the secondary will increase. With this arrangement, the voltage increase in the secondary is a linear function of the movement of the primary. The alternating voltage induced in the secondary is rectified, as in the case of the instruments previously discussed, and the rectified current actuates the indicating and recording instruments.

Operators generally hold a listening rod against the turbine cylinder or gland casing to detect rubs. Vibration set up by the rub is transmitted through the rod and can be heard when the rod is held against the ear. This method is certain but has the disadvantage of serving only when an operator devotes his whole time to it. With the noise-meter, the sound vibration at different points on the cylinder and at the gland casings is picked up by noise detectors and transmitted to the control board where it is amplified and shown on an indicating meter.

The detector is a high frequency magnetic vibration pickup, and consists of a permanent magnet flexibly supported, and a coil mounted between the magnet pole faces and rigidly attached to the case. When the case vibrates the magnet will remain stationary due to its inertia, while the coil will vibrate with the case, and due to the relative motion between the magnet and the coil, a voltage will be induced in the coil.

The magnitude and waveform of the voltage is directly related to the vibration, and the noises heard in the headphones have the same characteristics as those heard with a listening rod.

By means of a selector switch, any one of the detectors may be connected to the amplifier, and thus the noise from any part of the machine may be observed from one central location. This represents a considerable advantage over using a listening rod, particularly on a large machine where the distance between the No. 1 gland on the h.p. turbine and the No. 4 gland on the l.p. turbine may be 50 ft. and the gland casings themselves not readily accessible to the application of the rod. An additional advantage lies in obtaining a quantitative measure of the sound on the meter.

The present trend to larger single steam generating and turbine-generator units lays greater emphasis on continuous service from each unit. Electrical control instruments reduce the hazards to operation that might result from human fallibility.

Economical Power Production in Great Britain

ANALYSES and summaries of the returns of fuel consumption and units generated for the year ended December 31, 1934, have lately been issued by the British Electricity Commission. The particulars relate to authorized electricity supply undertakings, traction authorities and certain non-statutory undertakings in Great Britain. Returns were received for 470 generating stations—a decrease of 19 from last year, the difference being due to the closing of 29 stations before January 1, 1934, and the putting into operation of three new stations and one standby station during the year.

The total kilowatt-hours generated at these stations was 16,896 million, an increase of 12.97 per cent over 1933, 11,479,000 tons of coal, coke, and oil being used, the advance in this case being 7.51 per cent. The 267 steam stations produced 95.52 per cent of the total. The average coal consumption per kilowatt-hour generated in the steam stations was 1.58 lb. against 1.65 lb. in 1933. The results ranged from an average of 1.35 lb. for the 25 stations producing over 200 million kw-hr. per annum to 7.71 lb. for the few with an output of less than 100,000 kw-hr. each.

Lowest fuel consumption per kilowatt-hour was returned by Battersea (London Power Co.) with 1.06 lb., but Barking B (County of London Co.) had the best thermal efficiency at 27.95 per cent (1.09 lb.), which was 0.71 better than the first-named. The performance of Clarence Dock (Liverpool Corp.), which secured the premier place in 1933, improved to 1.09 lb. and 26.82 per cent, giving it a lead over Ironbridge (West Midlands J.E.A.), which secured 26.12 (1.4 lb.). Dunston "B" (North Eastern A. S. Co.), which has been handicapped by the change of frequency complications, nevertheless attained 25.35 (1.22 lb.).

THE ANNUAL REPORT of Northern Power Company (Delaware) and subsidiaries for the year ended December 31, 1934, shows an increase in gross operating revenues of $1,115,484, or 3.60 per cent, compared with 1933. Operating expenses, exclusive of appropriation for retirement reserve but including provision for income taxes, were $18,008,365, an increase of $1,683,541, or 10.31 per cent. Taxes, including provision for income taxes, included in the above amount, were $4,514,037, an increase of 18.57 per cent compared with 1933, and represented 25.06 per cent of such operating expenses. Of each dollar of operating revenues, 14.07 cents was required for taxes. Net operating revenues amounted to $11,723,209, a decrease of 5.54 per cent.

Combustion Control

Part VI—A-Jacks control of the National Regulator Co. for boilers operating at from 15 to 300 lb. pressure

A-JACKS CONTROL for high pressure boilers is built by the National Regulator Co. and, as shown by the typical installation drawing Fig. 1, consists of an overfire air control A, actuated by furnace draft, and a steam damper regulator B actuated by steam header pressure. The control is built in standard models for pressures of from 15 to 200 lb. and special models for pressures of from 200 to 300 lb. Both A and B are fundamentally the same except for the method of operating the control valve. In the former the control valve is operated by a sealed bell while in the latter the control valve is operated by an auxiliary piston and spring loaded check valve which will be described in detail later.

The control may be installed on hand-fired, stoker-fired, pulverized fuel or oil burning equipment and provides automatic control, with gradual movement of the damper to compensate for variations in steam pressure. The function of the control can be described briefly as follows:

An increase in steam load results in an immediate drop in boiler pressure. The regulator will then operate to increase the opening of the damper, increase the stoker speed and increase blower speed to bring boiler pressure back to normal. The reverse of this takes place when the load drops. The tendency toward an increase in boiler pressure causes the regulator to decrease the opening of the damper and lower the speed of stokers and blowers so as to hold the boiler pressure at the desired point. Between sudden changes the regulators operate constantly to maintain normal boiler pressure through balanced control of dampers, stokers and blowers.

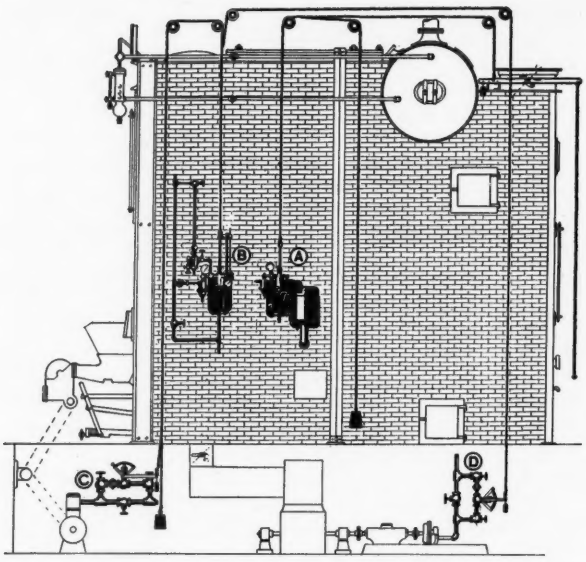
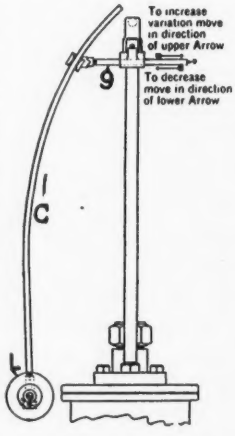


Fig. 1. Typical installation of A-Jacks control on a stoker fired boiler. A, overfire air control maintaining constant furnace pressure. B, steam damper regulator operating from steam pressure. C and D, cam valves for control of stoker and fan speed

Figure 1 illustrates the application of combined steam-damper regulation and overfire air control to a forced draft, stoker fired boiler. The steam damper regulator B, shown in detail by Fig. 3, controls the speed of the stoker and forced draft fan through cam valves D, in accordance with the steam pressure. These valves, D, acting as throttle valves, are of the globe type and the position of the piston type valve is controlled by a specially shaped and adjustable cam in order to compensate for the varying characteristics of the different pieces of equipment and to make the speed changes proportional to the movement of the regulator.

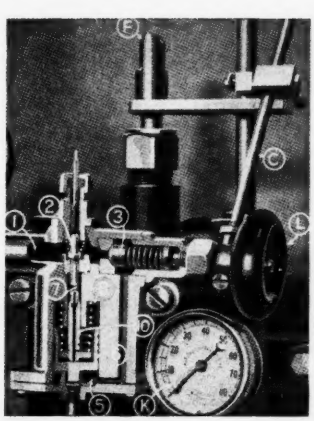
In this installation the uptake damper movement is controlled from the furnace pressure or draft overfire control A, shown in detail by Fig. 4. Engineers either know or can easily determine the exact furnace pressure at which each boiler should operate to secure the utmost efficiency from the fuel consumed, as boilers, even of the same design and rating, often require different furnace pressures for the most efficient operation. On boilers operating with steam pressures under 200 lb., the steam connection for operation of the overfire control can be made directly from the main steam header. Where steam pressures exceed 200 lb., reducing valve should be used or the control may be operated by compressed air of 30 lb. pressure or over. Either steam or air may be used without change in design or parts except for the lubricator.

Fig. 2. Arrangement of the adjustable compensator on the regulator shown in Fig. 3



The compensator, adjustable by means of rod 9 to permit a variation in boiler pressure of from 1 to 15 lb. for a full stroke of the regulator piston, acts as a control to the speed and sensitivity of the governor valve. Up and down movement of the piston rod causes in and out movement of lever C and changes the setting of adjusting wheel L as determined by position of rod 9.

For example, with a normal steam pressure of 150 lb. and adjusted for a 10 lb. variation (to allow a minimum of 145 lb. and a maximum of 155 lb.), each variation of 1 lb. in boiler pressure between these limits will move the regulator piston 1 in. Moving rod 9 to the right increases the variation, moving it to the left decreases the variations to any value up to the maximum which can be obtained, 15 lb. The shape of the rod C is such that the regulator piston always moves equal increments for equal changes in pressure, the extent of this travel depending upon the position of the rod 9 at the time. The compensator rod is attached to the valve stem of L with a clamp and does not interfere with the hand adjustment of L when required. That is the normal pressure adjustment may be changed from 150 to 130 by means of handwheel L without changing the 10 lb. pressure variation of the compensator.



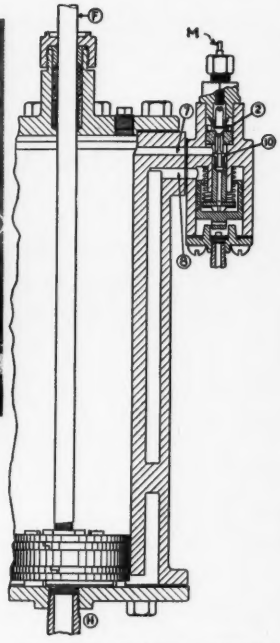
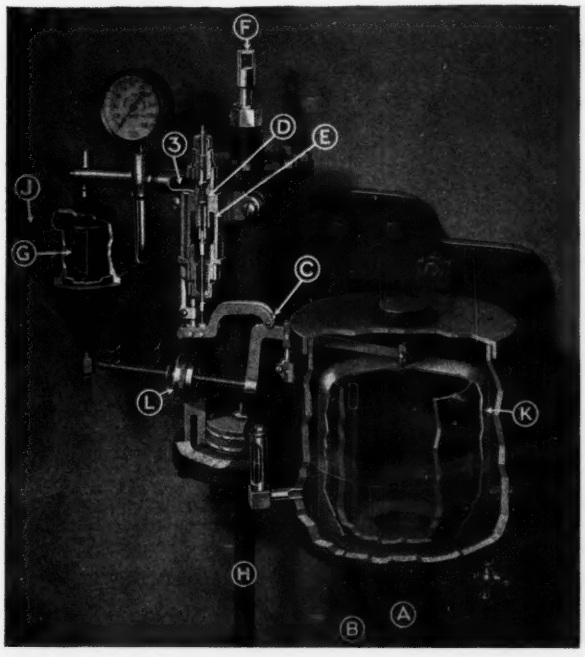


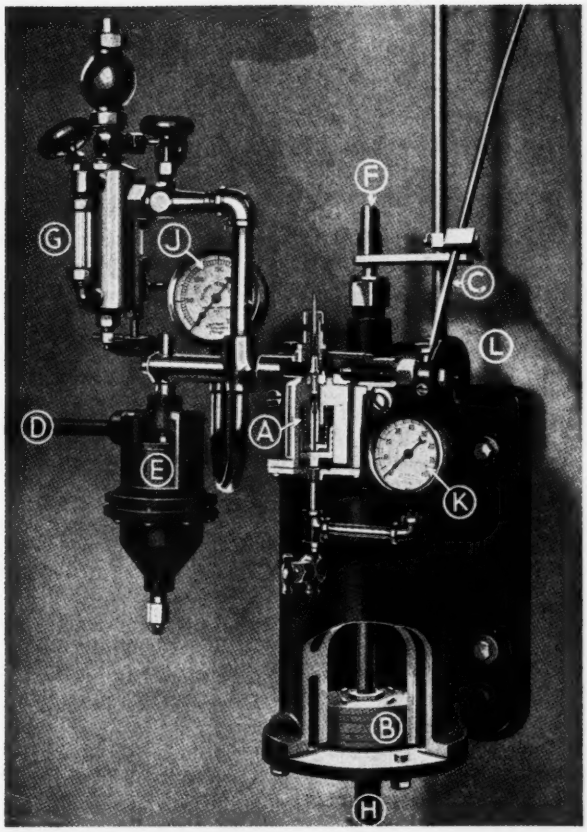
Fig. 3. (Right and above) Details of construction and operation of the A-Jacks steam-damper regulator

This regulator, with a heavy, one-piece, jacketed cylinder, 3½ in. bore and 10 in. stroke, operates on the principle of a safety valve. Governor valve A controls the movement of a regulating piston B, which is connected by a chain or cable from the piston rod F to the apparatus under control. This valve has four working parts: check 2, ball check 3 and plungers 6 and 10. The regulator is adjusted to the desired boiler pressure by the handwheel L which controls the tension of the spring against ball check 3.

Dry steam, direct from the boiler header, enters the valve through chamber 1 and is resisted by ball check 3 up to the pressure at which the regulator is set. When the boiler pressure exceeds this value, unseating ball check 3, steam passes ball check 3 and accumulates in chamber 5 until it reaches 4 or 5 lb. (as indicated on gage K), to raise plungers 6 and 10 and lift check 2 from its seat. This permits steam to pass directly from chamber 1 to the top of piston B through port 7 and forces the piston down, tending to close the damper and reduce the speed of the stokers and blowers.

When the boiler pressure falls below the point at which the regulator is set (by the position of handwheel L), ball check 3 closes and the pressure in chamber 5 falls, permitting plungers 6 and 10 to move downward. This allows check 2 to seat, cutting off the steam flow to the top of cylinder. Steam from the cylinder is exhausted back through port 7 (down through plunger 10 to escape through port 8, to the steam jacket of the cylinder and exhaust H), as counterweights on the dampers, stoker and blower controls pull the piston toward the top of the cylinder. The action of the compensator C is described in Fig. 2.





Stem M controls the lift of the check 2, and consequently the rate of flow of steam to the operating piston. In service M is adjusted so that the piston travels from the top to the bottom of the cylinder in from 2 to 5 sec. Due to the design and interrelation of checks 2 and 3 and plungers 6 and 10 these parts are in constant movement, check 3 vibrating about 600 times, and check 2 about 30 times a minute.

The arrangement shown by Fig. 1 although typical of the control for that type of installation, is but one of the many possible arrangements made to suit the individual needs of any boiler or group of boilers. With several boilers one steam damper regulator might, for instance, control the fuel feed, forced draft fan of all boilers, and the main breeching damper as well, while the overfire air control on individual boilers would regulate the uptake damper of each boiler to meet its individual needs. With motor driven auxiliaries the regulators can be used just as effectively as with steam driven equipment.

Fig. 4. (Left) Construction and operation of the A-Jacks overfire control

This control is practically the same as the steam-damper regulator, Fig. 3, with the addition of the gasometer and changes in the governor valve to meet the requirements of overfire regulation. Pipe A runs from the base of the gasometer through the furnace fire wall, above the fuel line, where it is subjected to the action of draft passing through the fuel bed. Pipe B is connected to a draft gage. The inverted aluminum bell K, floating in an oil seal, is balanced against the correct furnace pressure by adjustable weight L. The uptake damper of boiler under control is connected to F by chain or cable.

Excess furnace pressure (too much draft) pulls the bell below the balanced position. Deficient furnace pressure (too little draft) allows the bell to float above its balanced position. This up and down movement is transmitted by compound leverage through the roller contact C to the valve controlling the movement of the regulating piston. When the furnace pressure is too high, steam admitted from J to 3 passes through port D (to the top of the cylinder as in the case of the steam damper regulator) forcing the piston down and pulling the damper toward a closed position. When the furnace pressure is too low, steam pressure is shut off from the top of the piston and a counterweight on the damper pulls the piston toward the top of the cylinder and the damper toward an open position.

Salvaging Condenser Tubes

Tubes Pitted Near Inlet End Cut Off and Stretched To Original Length with Inexpensive Equipment Made from Parts Found in Any Large Power Plant

By H. S. MARKEY
Pacific Gas & Electric Co.
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PROTECTION of condenser tubes against the corrosive or erosive action of the sea water when used for circulating water is a problem that has so far baffled the engineering profession. The attack is sometimes local and thousands of condenser tubes have been scrapped because of the loss of a fraction of an ounce of metal resulting in a hole one thirty-second inch or less in diameter through the wall of the tube. The method described below of salvaging a set of punctured and nearly punctured condenser tubes applies only to tubes which are eroded in a special but not uncommon manner.

Tubes were eroded from the inside nearly through the walls; almost all of the damage being confined to the inlet end and within the limits of the first foot. Similar action is observed at the outlet end of some tubes but to a very much less depth and extent. The remainder of the bore is rough and scaled and by no means equal to a new tube. However there is no pitting or apparent loss of thickness and this part of the tubes is much too good to be thrown away. The condition described is remarkably uniform throughout the lot.

The single pass condenser in question contains 5490 tubes $\frac{7}{8}$ in. O. D., 16 B. W. G. and 22 ft. long. The tubes are of Admiralty metal to the usual specifications and are expanded into the tube sheets at both ends. Expansion is provided for by inserting a rubber fabric expansion joint in the condenser shell.

Salvaging consists in cutting off 1 ft. from the bad end of the tube and then stretching the remaining 21 ft. of good tube to its original length of 22 ft. Stretching is confined to 20 ft. 10 in. of the finished tube, leaving 12 in. at the inlet end and 2 in. at the outlet end the original diameter and thickness. Then, providing the character of the erosion remains unchanged, the processed tube will have nearly the same life as a new tube. It is necessary to stretch the tube about 1 in. longer than finished length because the tube contracts elastically that amount when the pull is released. After cutting off the tube, either end may be chosen as inlet end, remembering only that the inlet end must be nearly perfect or the tube must be discarded. It is expected that a slightly worn outlet end will outlast the nearly perfect inlet end.

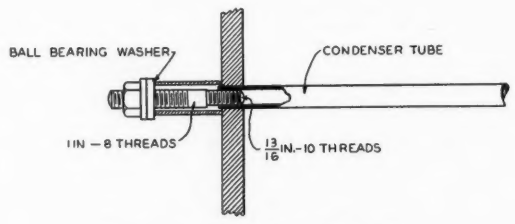


Fig. 1. Drawbolt for pulling tubes

Two processed tubes were measured for outside diameter along the stretched part. A pair of measurements at right angles were taken at ten places about 2 ft. apart on each tube, yielding forty measurements. The average of the forty measurements gave an outside diameter of 0.852 in. with maximum and minimum diameters of 0.856 and 0.850 in. From these measure-

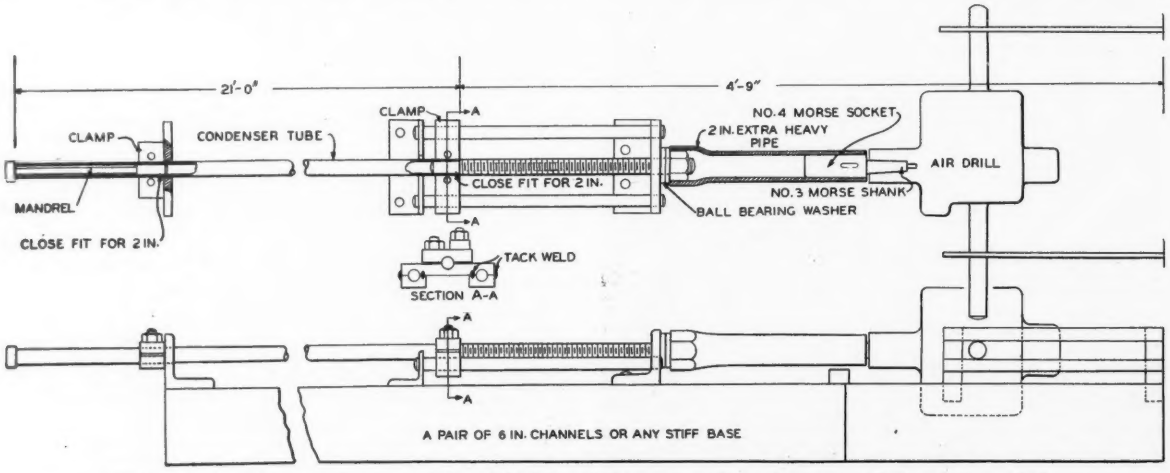


Fig. 2. The tubes are drawn to their original length by means of an air motor and threaded mandrel

ments and knowing the quantity of metal in the unstretched tube the following figures are obtained:

	Original	Stretched
Outside diameter	0.875	0.852
Thickness	0.065	0.063
Inside diameter	0.745	0.726

Samples from stretched tubes were submitted to test for susceptibility to season cracking and to microscopic examination and proved to be satisfactory. This would be expected from the fact that the metal is stretched only five per cent or less than would result from cold bending the tube to a radius of ten diameters.

Tubes are removed from the condenser in the following manner. A fine thread tap Fig. 1 is run into the outlet end of the tube and a draw bolt inserted by the use of which the tube is stretched about 1¼ inches drawing the expanded part out of the tube sheet and leaving the tube loose in the hole. The expanded part is then sawed off. The operation is repeated on the other end except that the tube is withdrawn instead of stretched. The draw bolt is provided with a 1 in. standard nut with a ball bearing washer under it. A wrench 18 in. long provides the leverage to stretch the tube and withdraw the expanded part from the tube sheet.

To stretch the tube a mandrel is inserted 12 in. into the inlet end. Two inches at the end of the mandrel fits the bore of the tube closely and the rest is relieved. A closely fitted external clamp is placed over the fitted part of the mandrel which when tightened clamps the tube to the mandrel. The clamp bears on a lug on the draw bench. The compression of the metal between the mandrel and the clamp is probably less severe than that due to expanding the tube in the tube sheet. Another mandrel is inserted 2 in. into the outlet end and clamped in the same manner. The extension of this 1 in. diam. mandrel is threaded 18 in. to receive a 1 in. standard thread brass nut 1½ in. long. A ball bearing washer is placed under the nut and bears on a lug on the draw bench. A compressed air drill, Little Giant Drill No. 1-X, furnishes the power to turn the nut and stretch the tube.

Some tubes were found which, when cut off and stretched, showed a denting or rippling on the outside surface extending along the tube from 1 to 4 in. near the outlet end. When sawed in half pitting was found under the ripples. All processed tubes were inspected externally for this indication of pitting. Several tubes which had been processed and replaced in the condenser but evidently not carefully inspected failed during the first two weeks of service. They were removed and the holes were found near the outlet ends. A little polishing on the outside revealed the rippling referred to and the tubes were found to be pitted under the ripples.

Justification for a similar job will depend on the cost of a set of new tubes, the cost of processing at the plant and the number of new tubes that must be purchased to replace tubes found to be defective after processing. The cost of removing and replacing tubes is the same for new or processed tubes.

Modernize *for* Profit

Advantages of Modern Equipment Outlined to the Louisiana-Mississippi Ice Association

By Mr. H. D. GRAHAM
York Ice Machinery Corp.

APPLICATION OF IMPROVED EQUIPMENT to existing ice plants for maximum profit should be given the same careful study as though it were an entirely new installation. There are no set recommendations for modernization that can always be made without first carefully checking the local conditions affecting the particular plant under consideration. Among these conditions are such important factors as yearly and seasonal load factors, and fuel costs, labor, type of plant, type and condition of the various portions of the equipment, etc.

Yearly and seasonal load factors have an important bearing on the relation of ice freezing capacity to ice storage capacity. An ice storage that is too large may incur useless expense for refrigeration, and conversely one that is too small may prevent continuous operation of the freezing system during periods when it would be desirable to accumulate a surplus in storage to meet later peak demands.

The load factor of a plant has an important effect on the selection of the type of prime mover to be used. In general, low load factors favor the use of electric drive, while the higher load factors point toward the use of oil or gas engines, for the fixed charges resulting from the greater investment required for engines is then spread over a larger production tonnage.

Choice between electric drive or engine drive, of course, depends upon the relation between the cost of electrical energy and oil or gas at the plant under consideration, together with the influence of load factor mentioned above, and labor costs. Except in unusual cases, steam drive and distilled water systems can hardly hope to produce ice as cheaply as modern raw water systems with electric or engine drive. Changing to the raw water system does not necessarily mean the complete rebuilding of the whole plant, but may require only the addition of the proper air system for agitation of the can water with necessary changes to the compressors.

In changing to raw water system, it is essential that the characteristics of the water to be used for ice making be checked so that the proper treatment can be recommended. This may be done by sending a 0.5 gal. sample of water to competent chemists to make a complete chemical analysis of the water from this analysis it is possible to predict the number of ice cans required per ton of ice, and the water treatment required to produce good, clear, salable ice.

Then with data on the plant load factor, electrical energy and oil or gas rates, the water analysis, and

labor costs, one can draw up a definite schedule of overall operating costs under the modernized raw water system. A comparison of modernized raw water manufacturing costs with cost records of steam operation will quickly demonstrate the savings to be made and the return on the investment required to convert to a modern raw water system.

In many present raw water ice plants, modernization can profitably be applied to one portion of the plant such as the freezing system, the compressors, the condensers, or other portions, even down to individual pieces of equipment. Many plants are equipped with the so-called hairpin style of ammonia coils between the cans, or brine coolers, and employing the hand expansion valve method of ammonia control.

It is profitable and entirely practical to replace these hairpin coils with the highly efficient vertical trunk type of coil which would operate at high back pressures and thereby reduce power costs per ton of ice. Roughly speaking, for each pound that the suction pressure is raised there is a decrease in the compressor horsepower per ton of ice of two and one-half per cent. Thus by raising the suction pressure of a plant only a few pounds, appreciable power saving may be made. The vertical trunk coil is equipped with a simple float control which automatically regulates the ammonia to just the right height in the coil, thereby freeing the engineer from the difficult task of expansion valve adjustment.

Modern vertical single acting enclosed ammonia compressor equipped with automatic lubrication are designed for direct connection to synchronous motors or oil engines or for the use of efficient vee-belt drives. There are many old style slow speed compressors of the horizontal or open frame type operating today which require extra attention from engineers, and which could be profitably replaced with modern enclosed compressors. Savings in power, ammonia, and maintenance would, in many cases, soon pay for replacement of these old style machines.

In the small single compressor plant having electric drive, two speed motors may often be profitably used to reduce the metered demand and increase the suction pressure during winter months. Another way of accomplishing the same result is by the use of partial by-passes on the compressor, which is an efficient way of reducing compressor capacity and power without changing the motor speed.

Modern shell and tube condensers in either the vertical open or horizontal closed type offer some distinct advantages over their predecessors, the older atmospheric or double pipe varieties. Chief advantage of the shell and tube condenser is the ease with which it may be cleaned, which means that the shell and tube condenser actually is cleaned oftener than the older styles. A dirty condenser means that the ammonia head pressure is higher than it need be and roughly speaking, each 10 per cent reduction in head pressure effects a saving of 5 per cent in compressor power, so it is apparent that a condenser that is easily cleaned will actually save power. Also, there is the freedom of the shell and tube condenser from threaded or flanged joints, all susceptible to ammonia leaks.

Much attention has been given to improvement of ice plant auxiliary equipment. Some auxiliaries operate almost continuously regardless of percentage of total capacity that the plant is producing; for example, the air blower although requiring fairly small power for driving, runs the greater part of the time. There are now available centrifugal type blowers with which the power is reduced as plant production is lowered during off-peak sessions, thus effecting power savings. Another individual piece of equipment which has been highly developed is the automatic ammonia purger designed to remove air or other foreign gases from the refrigerating system. The fully automatic purger will separate foreign gases from ammonia to a much finer degree than can be done by usual hand methods of purging, and can do this without losing the quantities of ammonia usually lost in purging by hand.

To ASSIST young engineers in self development during their entrance into engineering work and after graduation, the Engineers' Council for Professional Development, which is a conference organized by engineering societies to better the status of engineers through promotion of study to give better understanding of technical, social and economic problems, has prepared reports on suggested reading, also a list of 65 questions by means of which the young engineer may test his present status in technical work, his personal relations and his program for development. This will give him a basis for a study plan to overcome individual weakness or lacks and to achieve his ambitions.

The reading list covers natural science, philosophy, economics, sociology, psychology, business and industrial management, literature, history, biography and travel and fine arts. For a period of 4 yr. a minimum of 25 books is recommended, at least one book in each classification, with the object of giving social and intellectual development to fit for valuable service to society and be conducive to proper public recognition of the engineer and the engineering profession.

Information as to the question list, the book list and provision for coöperation by student and local branches of engineering societies and by correspondence may be secured from the Council, George T. Seabury, secy., 29 W. 39th St., New York, N. Y.

IN THE MANAGEMENT of a power plant, the operating personnel needs as much if not more attention than the mechanical and electrical equipment, and a periodic check up is a practice well worth putting into effect. It is well to make at least an annual review of such questions as making certain that each man in the organization is doing the job for which he is best fitted, that every function is being capably performed, that outstanding ability and industry are being encouraged and rewarded, and that operators are being properly developed to accept increased responsibility as the business grows or when it becomes necessary to replace the present key men.

WHEN A TRANSFORMER is connected to a power circuit, the transient rush of current depends upon the point on the voltage wave at which the circuit was closed. This transient current may greatly exceed in value the rated load current of the transformer.

Operation and Regulation Characteristics *of* Centrifugal Pumps

Why Centrifugal Pumps Have Different Characteristics. Adjustable Blade Propeller Pumps Have Advantages for Low Head Work, Recent Pump of This Type Alternates as Pump and Turbine

By G. HERMANN
Escher-Wyss Eng. Works, Ltd.
Zurich, Switzerland

AS A RESULT of varied requirements placed on centrifugal pumps, impellers have been developed which differ greatly from one another, but which, if grouped correctly, show a consequential development both as regards their shape and the output. Impellers for high delivery heads have a long radial development. The diameter at exit D_2 is considerably greater than the diameter at entrance D_1, as in Fig. 1A. The smaller the maximum delivery head to be overcome by the impeller, the smaller can the ratio of the diameters at exit and entrance be, the width of the impeller increasing at the same time. As a result of this development, the purely radial exit is abandoned and, in the screw-type pump, takes the form of a semi-axial discharge, while in the impeller pump the flow is in a completely axial direction as in Fig. 1D.

For the purpose of comparing the various impeller shapes with one another in as simple a manner as possible, and without having to consider in detail the relationship of the individual dimensions, the specific speed n_s is taken as the characteristic value.* This is representative of the relative development of the impeller and denotes the speed. Figures 1A to 1D show impellers for various speeds, the specific speed for the point of highest efficiency being given. Further, the maximum admissible delivery heads in meters (= 3.281 ft.) which the impellers can overcome without cavitation occurring, i.e., without diminution of the delivery volume and efficiency, and without corrosion of the impeller, are also indicated. A suction head of about 6½ ft. has been assumed. From these figures it can be seen that high-pressure impellers have small values of n_s, and low-pressure impellers high values.

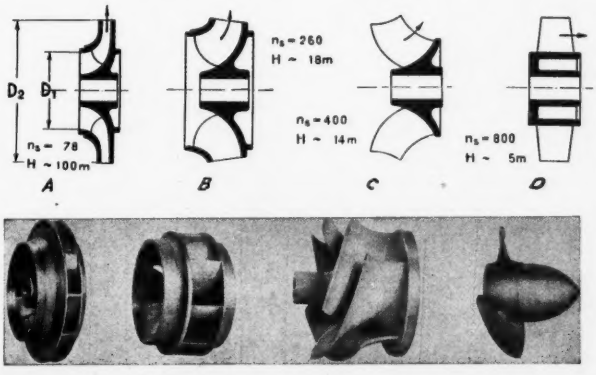


Fig. 1. Photographs and sectional drawings of impellers for various specific speeds as indicated. The specific speed n_s is for maximum efficiency, the head H is the maximum delivery head without running risk of cavitation

*As with hydraulic turbines, the specific speed indicates the type or classification of the impeller, but as capacity rather than power is the primary consideration the specific speeds of the two are expressed in different forms of the same fundamental equation. For pumps the specific speed can be calculated by multiplying the actual speed by the square root of the capacity and dividing by the three-quarters power of the head. The numerical value will of course depend upon the units used. The specific speeds shown here refer to Metric units.

A knowledge of the variation of the quantity-head or Q/H curve, and the efficiency and power consumption characteristics is of the greatest importance for the correct choice of a pump. The variation of these curves, as shown in the diagrams Figs. 2A to 2D, is seen to follow a law which can be expressed as a relationship of the specific speed, and according to which the behavior of various pumps under partial load can be judged. From the diagram Fig. 2A it can be seen that, when drawn with the delivery volume as abscissa, the Q/H curves are flatter, the lower the speed. The efficiency curves referred to the corresponding Q/H lines are reproduced in Fig. 2B and the corresponding power consumption curves in Fig. 2C.

Since with widely varying delivery volume a flat efficiency curve is desirable, in order that the pump may work economically on partial loads, it is seen from these diagrams that a low value of n_s is to be aimed at. A striking point is the difference in the efficiencies when the delivery head is constant and the pump must be throttled down to supply a smaller quantity of water. The efficiency is then diminished by an amount corresponding to the delivery head dissipated in the throttle valve, and which is equivalent to the difference between the head given by the Q/H line and the head determined by the external conditions.

Starting Propeller Pumps

Figure 2D shows the efficiency curves referred to constant delivery head. Apart from the regulated pump, which will be specially referred to later, it is seen that the low specific speeds show to best advantage. High-speed propeller pumps, however, cannot be used for throttle regulation, because, due to the rapidly falling efficiency curve, the power consumption of these pumps at partial load is higher than at full load. For this reason propeller pumps are never started against a closed valve, i.e., with zero delivery volume, because in such a case the power consumption would be nearly double the normal value and

would necessitate a heavily over-dimensioned motor for this kind of starting.

Curves reproduced were taken on pumps with which high efficiencies, between 80 and 90 per cent, were attained at the most favorable point. By modifying the design it is possible to vary the curves somewhat, but the relationship shown between the efficiency and the specific speed of the impeller remains essentially unchanged. The purpose of Fig. 2 is to show the principal features of the various characteristic curves.

It can be seen from the diagrams that, with variable delivery volume, the pumps of lower specific speed deserve preference for hydraulic reasons. On the other hand, a low-speed pump has large dimensions, and the machine driving it must be heavier than that for a high-speed pump. For economic reasons, therefore, a speed is generally chosen at which, for the given operating conditions and suction head, no cavitation will take place. As a result, lower first costs for the pumping station are frequently obtained at the expense of a less satisfactory efficiency characteristic.

A well-known solution to the problem is to provide the driving machine with variable speed. In this case, however, it must not be forgotten that altering the speed not only varies the delivery volume but also results in the maximum efficiency being obtained at a different delivery head. Figure 3 shows the variation of the efficiency of a drainage pump using throttle regulation and speed regulation. The gain in efficiency is considerable, though in practical operation difficulties are frequently encountered in obtaining sufficient variation in the speed.

This regulation can be readily carried out when the pumps are driven by direct-current motors, as their speed can be carried practically as widely as possible by regulating the shunt excitation. Steam engine or Diesel engine drive can also be used very satisfactorily. In the case of the three-phase motor drive, which is most widely used, speed regulation without losses necessitates an expensive design of the electrical machine which is only rarely economically justified.

Another way of regulating the speed is to switch resistances into the circuit, though this introduces additional losses which are approximately proportional to the change in speed. In spite of these losses, however, the more satisfactory operation of the pump enables a better overall efficiency to be obtained than when throttle regulation is used. A solution which approaches speed regulation without losses is to use motors with a variable number of poles, giving two or three different speeds. Since, however, the motors must run at their synchronous speeds, a more or less sudden adjustment to the different operating conditions has to be made and, in addition, these special motors are considerably more expensive.

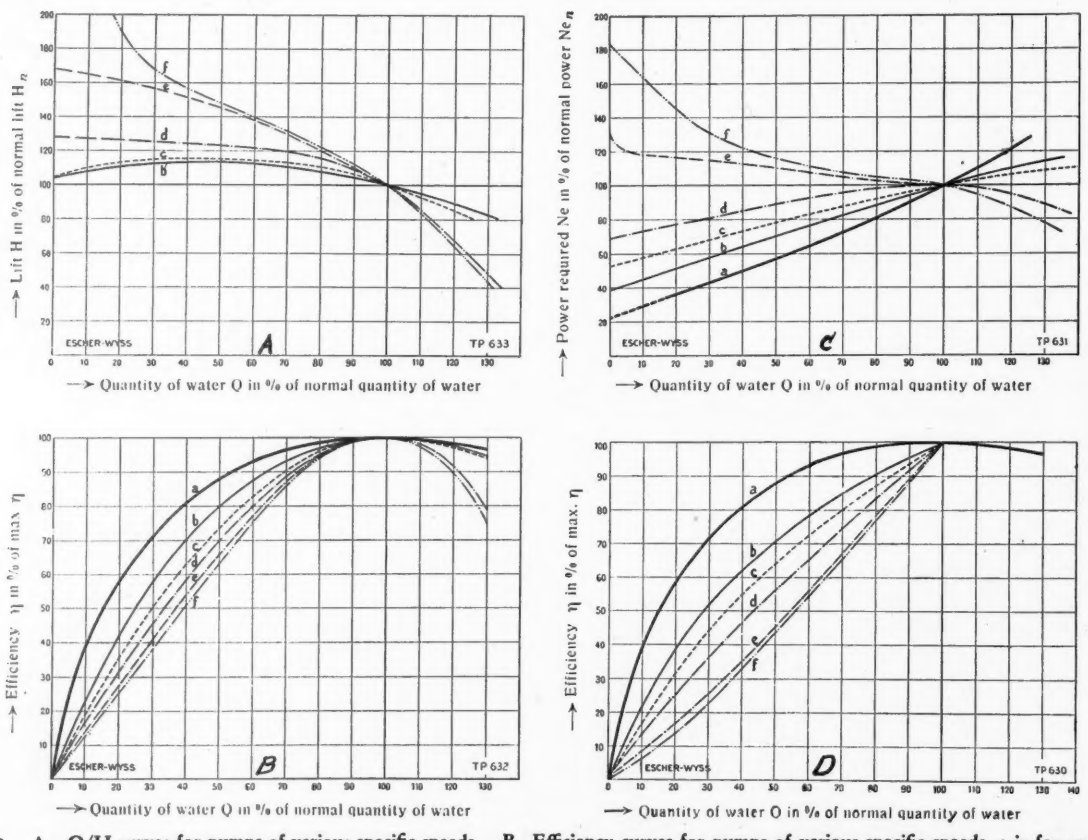


Fig. 2. A. Q/H curves for pumps of various specific speeds. B. Efficiency curves for pumps of various specific speeds, a is for constant head, the others for heads as shown by Fig. 2A. C. Power consumption curves for pumps of various specific speeds. D. Efficiency curves for pumps of various specific speeds referred to constant delivery head.

References to Figs. 2A to 2D: a, propeller pump with adjustable impeller blades n_s = 400 to 1100; b, high pressure centrifugal pump, n_s = 78; c, centrifugal pump, n_s = 125; d, low pressure centrifugal pump, n_s = 260; e, screw pump, n_s = 400; f, propeller pump, n_s = 800.

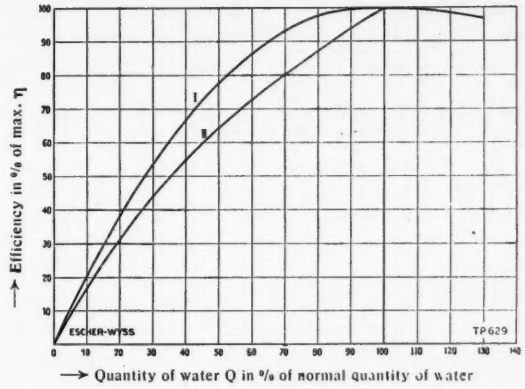


Fig. 3. Efficiency curves of a large pump for constant delivery head with, I, speed regulation and, II, throttle regulation

For the range of propeller pumps or screw pumps with n_s equal to, or greater than, 400 it has been found that the most satisfactory method of obtaining various delivery volumes with slight variation in the delivery head is to turn the blades of the pump impeller. Pumps of this type have been thoroughly investigated by Escher-Wyss and made in large numbers. The results obtained with such pumps are shown by curve a in the diagrams of Fig. 2, from which it will be seen that the characteristic curves are considerably more favorable than those of a pump running at the lowest specific speed.

A propeller pump with adjustable impeller blades can be adjusted to a wide range of delivery volumes, the favorable variation of the power consumption characteristic being particularly noteworthy. The complete operating range of a pump with adjustable impeller blades is reproduced in Fig. 4. The Q/H curves shown for various blade adjustments are values taken at random, and can be replaced by any intermediate position according to the required delivery volume. The power consumption curves for constant delivery heads are also shown in the diagram.

The design of the adjustable propeller pump can be seen from Fig. 5. The blades are all connected by links to an adjusting head, which can be moved by means of a spindle passing down through the hollow pump shaft. In the pump illustrated, the blades can be adjusted while the pump is running. A simpler solution is to mount the handwheel for turning the blades on the shaft, though in this case the blades can only be adjusted when the pump is not running.

In order that the motor must not be chosen unnecessarily large, the power consumption characteristic should be horizontal or only slightly rising. This determines essentially the maximum admissible specific speed, and prevents the high speed, which would be allowable from the point of view of cavitation, from being adopted.

The quantity of cooling water required for the condensers in thermal power stations is subject to considerable fluctuation according to the load taken up by the turbo-generator sets. The requisite cooling water pumps have to overcome in most cases a head which is below 40 ft. Propeller pumps with adjustable blades are suitable for this purpose because they are even superior to pumps the speed of which is

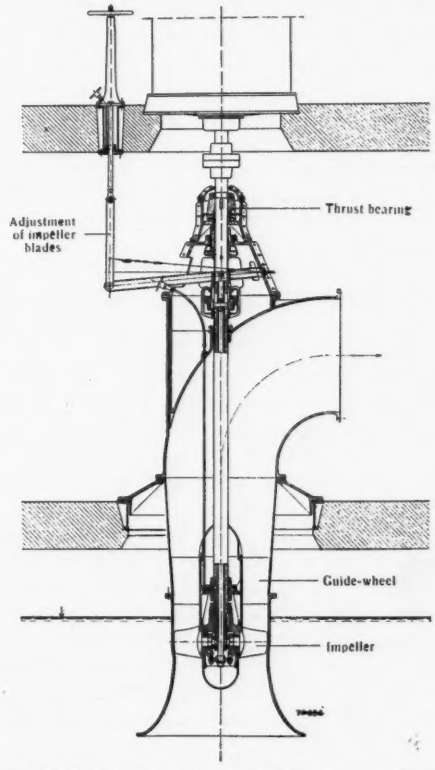


Fig. 5. Sectional drawing of a propeller pump with adjustable impeller blades

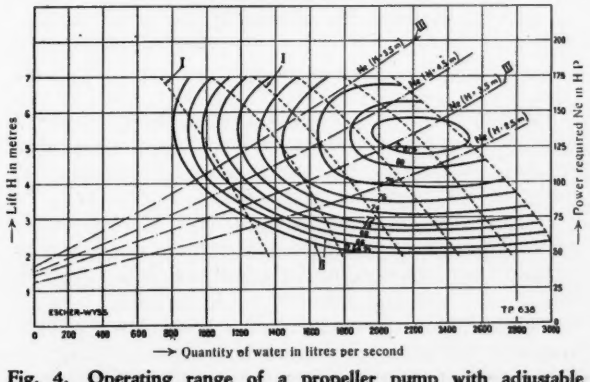


Fig. 4. Operating range of a propeller pump with adjustable impeller blades. I, Q/H curves for different blade positions. II, Curves of constant efficiency. III, Power consumption of pump for constant delivery heads

adjustable. For a steam power station in Holland the Escher-Wyss Engineering Works, Ltd., are supplying four cooling water pumps of the propeller type with adjustable impeller blades, each pump being capable of delivering 19,600 g.p.m. against a head of 38 ft. As a result of exhaustive cavitation tests, the pumps have been designed to work with impellers arranged below the suction level.

A machine which deserves special attention is one supplied by Escher-Wyss for the Baldeney Plant of the Ruhrverband at Essen, and which is to be used alternately as turbine and pump. It is fitted with adjustable impeller blades and supplies 79,500 to 106,000 g.p.m. against a delivery head of 30 ft. It is particularly worthy of note in that it is the first machine to be used both as a turbine and a pump.

Pulverized Fuel Burning Experience *at* Goodyear Plant

Summary of Year's Experience with the First High Pressure Plant in the Rubber Industry

By HARRY A. DAVIS
Manager, Steam Engineering & Maintenance Dept.
The Goodyear Tire & Rubber Co., Akron, O.

THE GOODYEAR TIRE & RUBBER CO. has the distinction of being the first plant in the rubber industry to use a high pressure steam boiler in conjunction with a non-condensing, extraction type turbine exhausting at 100 lb. pressure for process uses. The first unit was completed and put into operation at the Akron plant February 23, 1934. This installation has definitely proved the commercial economy of high pressure equipment for steam-electric generation wherever steam at lower pressures is available for process work.

Many operating difficulties were looked for with the first installation at this radical increase in pressure but fortunately those difficulties that were expected failed to materialize. Of the few minor troubles experienced none were of such a nature as to cause any doubt about the success of the project. In fact, the first year's operation shows that the expected economies have been realized and the costs of construction were such as to justify further installations at the higher pressures.

Nearly every article that has been published relating to operating experiences in high pressure plants states that no difficulties have been experienced which are directly attributable to high steam pressure. The truth of this depends largely upon a rather strict interpretation of the word "directly" as difficulties are relative and a condition considered a serious inconvenience in one plant would be accepted as all in the day's work in another.

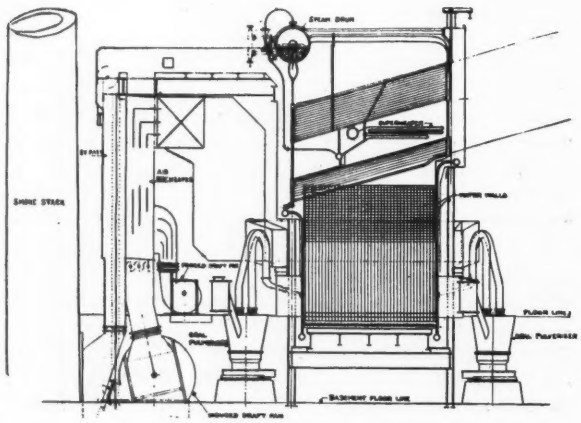


Fig. 1. Cross section of the slag tap boiler showing the furnace construction and location of auxiliaries

We all know that the successful management of a modern boiler plant requires more skill, wider knowledge, and greater attention to detail than was required in the up-to-date plant 10 or 15 yr. ago. Directly or indirectly, higher pressure has contributed to the increased responsibility carried by the chief operator of today. Higher rates of combustion and higher rates of heat transfer are the principal causes of the changed technique of boiler operation. Undoubtedly, however, the use of higher steam pressures is an important feature in creating a definite trend toward extra high ratings. High pressure boilers are more expensive than low pressure boilers, and it is necessary to get more steam out of each unit of heating surface. This has reduced the unit cost, not only on the boilers, but also on the settings, foundations and buildings. Efficiencies have been increased by equipping the boilers with economizers and air heaters, which are cheaper forms of heating surfaces for obtaining low exit gas temperature.

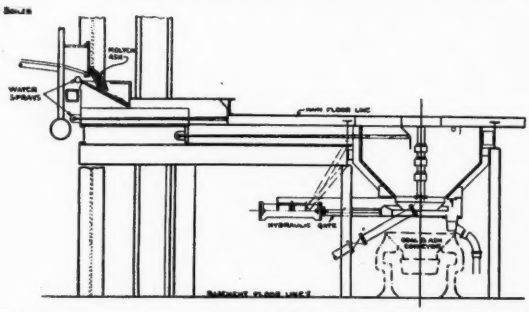


Fig. 2. Arrangement of the sluice system for ash disposal

Feedwater Purification

One of the first problems arising from the effects of higher steam pressures and higher rates of heat transfer was feedwater purification. Formerly feedwater treatment was a minor operation. We were content to accumulate a normal amount of scale in the boiler tubes and to turbine them at regular intervals. In many sections such purification was obtained by the use of soda ash, and sometimes a little lime.

With higher pressures and higher rates of heat transfer this same procedure became inadequate. It was observed that small amounts of scale would cause tubes to sag and blister. This was particularly true in the radiant heat absorbing surface, the relative

quantity of which was much greater than in the older type of plant. The modern plant would never have been practicable without the water cooled furnaces and slag screen and other additions to the radiant heat absorbing surfaces. These new developments simplified the maintenance of the furnaces, but increased the importance of correct feedwater treating in the majority of industrial plants.

In the design of this boiler we eliminated the economizer and placed additional heating surface in the boiler and air preheater and, with slightly higher initial cost, our ultimate results were the same from an efficiency viewpoint. In addition to this we have no economizer troubles common to many plants, especially those where the raw water makeup is high. We are able to pass our treated water direct to the boiler where it is under absolute control.

The treatment may be simple or complicated, according to the quality of the raw water and, except in very unusual cases, satisfactory softening can be accomplished. Coincident with getting rid of boiler scale, two new problems arose—corrosion and embrittlement. Both had been experienced in the older plants under unusual conditions. Corrosion may be occasioned by incorrect chemical treatment, but the presence of oxygen in the water is a more common cause. In the earlier plants slight scale formations protected the metal from corrosion. Corrosion, however, is a chemical reaction and takes place more rapidly at higher temperatures. The only way that serious corrosion can be avoided is to maintain correct feedwater treatment and then to deaerate the feedwater and keep it deaerated.

While embrittlement is as much a matter of boiler design and fabrication as of chemical treatment, and while the boiler manufacturers have done their part to reduce the hazard, it has been found that embrittlement can be entirely inhibited by correct chemical treatment of boiler feedwater. Fifteen years ago, "hardness" was the only technical term in regard to feedwater treatment which the average boiler plant operator needed to know. If he was erudite, he would distinguish between temporary hardness and permanent hardness.

Now he has added at least three important items to his vocabulary; "pH Value," a measure of acidity or alkalinity of the water; sulphate-alkalinity ratio, which determines the degree of embrittlement inhibition; and oxygen content. All three must be maintained within prescribed limits in the modern high pressure, high rating plant.

Successful operation is not merely a matter of analysis and chemical feed; it requires painstaking attention of the chief operating engineer to the operation of deaerators, maintenance of condenser tubes, disposition of drips and all returns; control of blowdowns; and many other details which are straight operating problems which require no knowledge of chemistry, but which do require a knowledge of the fundamental necessity of clean non-corrosive feedwater.

Boiler Operation—Performance Results

Nothing can be said regarding the availability factor of this boiler unit which would be representative of a pulverized fuel fired boiler room, because this unit is operated with other stoker fired equipment; and it is desirable to have this boiler out of service during periods of low load. This situation occurs at present on Sundays and holidays and such periods can be utilized to inspect and make any necessary repairs without taking the boiler out of service when there is a demand for its service. Slagging of boiler tubes is not serious enough to interfere with sustained operation at high rating when burning Pittsburgh No. 8 Ohio coal. This coal gives a very good furnace performance on slag-tapping units of the type shown in Fig. 1.

The furnace possesses many interesting features. The upper furnace walls and floor are constructed of Bailey blocks. The lower part of the furnace wall is of the stud tube construction. The Bailey stud construction is used on all four walls from a height approximately 1 ft. above the floor to approximately 13 ft. above the floor and the Bailey smooth bare metal blocks are used in all four walls above the studded portions. Presenting a continuous heating surface to the fire the total area of the water cooled furnace and floor is 2776 sq. ft., and at maximum load the heat liberation will be 32,700 B.t.u. per hour per cubic foot of furnace volume. The slag and ash resulting from combustion are kept in a molten state in the furnace

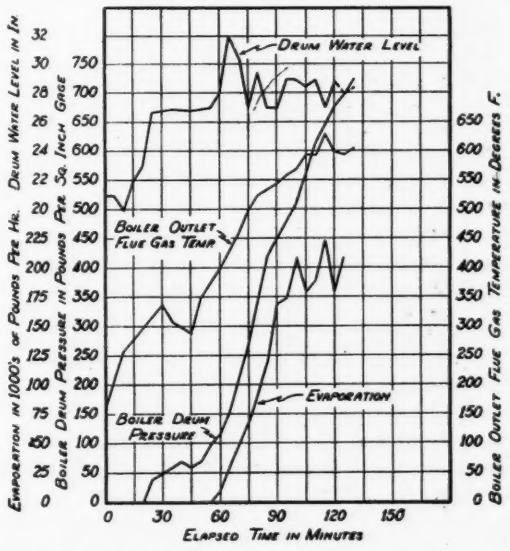


Fig. 3. Record of conditions when starting boiler from cold

bottom and drawn off at suitable intervals into a specially designed sluice shown by Fig. 2. In this sluice the action of water jets on the molten slag discharge breaks it up into a finely divided state so that it can be easily carried out for disposal into the present ash hopper.

The Goodyear Tire & Rubber Co. at Akron is so located that the logical fuel is the Ohio Field, Pittsburgh No. 8 coal. The considerations affecting the selection of this coal were the price per million B.t.u. delivered at the plant, the fluid temperature of the ash, grindability, moisture and volatile matter. Of these factors, price and fusing temperature of the ash and grindability were of prime importance. No definite premium could be assigned to grindability, except

to give preference to the fields which on laboratory tests have shown a high grindability factor.

As the ash fusing temperature approaches 2400 deg. F. the fuel becomes unsatisfactory for slag tapping so that the Pittsburgh No. 8 Ohio coal with its low ash fusing temperature lends itself well to this type of ash removal system. A year's operation has now demonstrated that this coal gives satisfactory operating conditions and has caused no difficulties. The furnace is tapped from one outlet in the center of the side wall and satisfactory tapping, at the rate of 4 to 5 t. per hr. is obtained at the steaming rate of from 100,000 to 350,000 lb. per hr.

Advantages of a slag tap furnace over a dry ash removal type, as they exist at present, are: Slag tap furnace can be installed at less overall expense, due to a more efficient use of building volume, less expensive ash handling equipment, etc.; higher efficiencies are developed due to more efficient absorption of radiant heat by furnace walls and increased turbulence of burner flame by impingement on furnace bottom; there are few, if any, restrictions in the selection of a low fusing ash steaming coal, and the Pittsburgh No. 8 Ohio coal has a distinct advantage.

Actual tests, under operating conditions, are the only reliable guides to the suitability of coal for slag tapping. For our furnaces, it is not satisfactory to use coal whose fluid ash temperature is above 2400 deg. F. The water-cooled furnace bottom has given no trouble from slag leaks. We have replaced approximately 75 eroded side wall blocks from along the slag line. We have also replaced a number of burner blocks. This difficulty was caused in most cases by uneven distribution of coal in the furnace. After considerable experimenting and adjusting, we were able to get a more uniform distribution of coal in the furnace and our furnace trouble was immediately reduced to a minimum.

Burners and Furnace

Each mill delivers coal to two cross tube burners arranged horizontally across each end of the furnace for opposed firing. This provides for well-balanced furnace conditions and individual burners may be cut out by closing a valve on top of the mill. The mills are set to grind to a fineness of approximately 70 to 80 per cent through a 200 mesh screen. There is an oil burner just below each coal burner for ignition purposes only.

All controls have been brought to a central location with the necessary instruments and devices provided, so that operation is greatly simplified. All adjustments for starting and stopping and changing the output are made from this central station. Sequence interlock relay protection is provided to guard against flarebacks or explosion, due to mechanical failures or mishandling. Figure 3 depicts graphically the sequence of burner operation followed from starting the boiler from a cold condition. The intent of this method is to apply heat gradually above the furnace so that the proper circulation may be established throughout in order to avoid excessive temperature stresses.

With the direct firing arrangement this necessitates operating the mills for short intervals in rotation. This is conveniently accomplished from the central control board. The boilers are started up after each week-end shutdown and the furnace is hot from the previous week's operation, as there has been very little loss in steam pressure from the previous week's operation. Under these conditions the unit goes on the line within a few minutes after the burners are lighted.

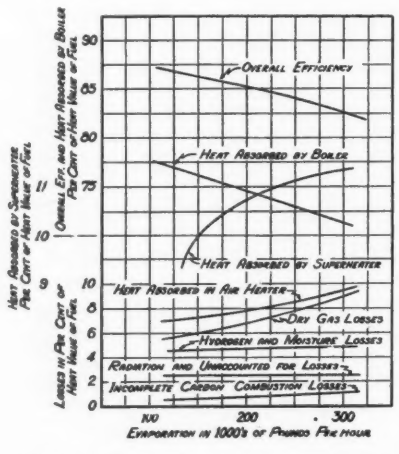

Overall Efficiency
Heat Absorbed by Boiler
Heat Absorbed by Superheater
Heat Absorbed in Air Heater
Dry Gas Losses
Hydrogen and Moisture Losses
Radiation and Unaccounted for Losses
Incomplete Carbon Combustion Losses
Evaporation in 1000's of Pounds Per Hour

Fig. 4. Heat balance and overall efficiency as determined from a year's operation

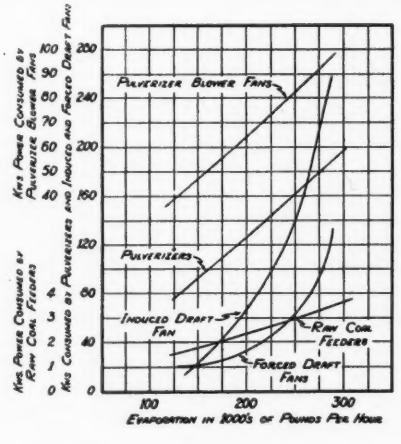


Fig. 5. Variation of power consumption of fans, pulverizers and coal feeders with load

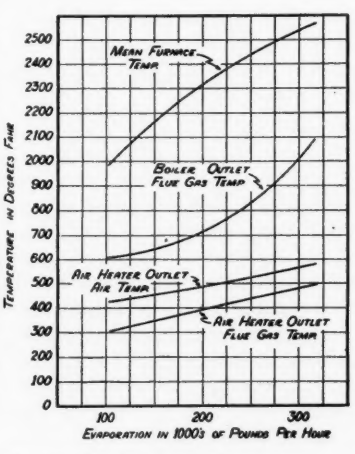

Mean Furnace Temp.
Boiler Outlet Flue Gas Temp.
Air Heater Outlet Air Temp.
Air Heater Outlet Flue Gas Temp.
Evaporation in 1000's of Pounds Per Hour

Fig. 6. Various gas temperatures as a function of the rate of evaporation

Capacity and Flexibility

The plant is very simple to operate, requiring two men on each shift, a combustion engineer and helper, exclusive of superintendents, test engineers, coal and ash handling force and maintenance men. Steam temperature of 750 deg. F. has so far shown no peculiarities to make us expect any trouble from this source. The maximum capacity of this installation is limited by the fans and the pressure drop through the superheater. With Pittsburgh No. 8 Ohio coal, the mill capacity is 10 per cent in excess of the other limiting conditions.

Minimum output is established by the minimum practical capacity of one burner. The heat radiated by the hot slag bottom provides strong ignition and minimizes the danger of flarebacks with one mill operation or under unfavorable coal feed conditions. The boiler has been operated for sustained periods at an output

as low as 55,000 and as high as 350,000 lb. per hr. but a more rational basis of rating for daily operation may be considered as from 200,000 to a maximum of 350,000 lb. per hr.

The accompanying table covering twelve months' operation shows a service record of the boilers and the performance results obtained. It is believed that where the boiler and turbine unit do not constitute a major portion of the total power generating facilities of a given system, the installation of a steam generating unit of a size to match the turbine is an economical and justifiable procedure.

High Pressure Boiler Operation for One Year from April 1, 1934 to April 1, 1935

Month	Monthly Peak Loads Lb. per hr.	Average Steam Output Lb. per hr.	Hours Boiler Operation	Steaming Efficiency in %
April, '34	313,000	237,886	511	84.2
May	309,000	238,529	544	84.4
June	315,000	239,749	518	84.3
July	321,000	237,701	395	84.4
August	319,000	244,261	517	84.2
Sept.	327,000	265,600	500	83.8
Oct.	323,000	258,941	577	84.1
Nov.	331,000	277,398	567	83.3
Dec.	335,000	269,867	509.25	83.7
Jan., '35	350,000	285,579	631	83.5
Feb.	339,000	275,323	575	83.6
Mar.	334,000	273,678	613	83.4

Test Data

In any chart giving the distribution of various heat items, the greater the number of sub-divisions, the more readily is it possible to locate the source of losses. In everyday furnace practice a determination of the heat balance is seldom attempted, because of the expense of obtaining the various factors entering into the calculations, and even if the expense is of secondary consideration, the results are likely to be more or less approximate.

In general the operating engineer is interested in the heat absorbed by the boiler and the relative source of heat loss up the stack. When the performance of different installations are to be compared, this offers a most satisfactory basis; but the operating engineer, in tracing out the source of heat loss with a view to bettering operation, is chiefly concerned with "coal as fired" and for this reason the heat balance is commonly expressed in terms of the latter. It is impractical to assign specific limiting values to a general heat balance, because of the wide range in the various influencing factors, such as nature and quality of fuel, type of furnace, etc.

The accompanying performance is in chart form. The performance record is a combined average for a period of one year, showing boiler steaming efficiency and the overall efficiency. The overall efficiency includes coal for banking, starting, steaming and usual operation. Performance on available records of the boiler are given by months in the table mentioned above. The performance of this unit has been very creditable during the past year closely approaching the design calculation and we believe the burning of pulverized coal in this plant has demonstrated its economy and reliability.

Welded coal bunkers, 48 by 40 ft. and 36 feet deep, are installed at Yalbourn power station, Victoria, Australia. They were built up of ½-in. plates, 8 ft. wide, stiffened by tees at 2-ft. centers.

Studying Steam Selling Costs

by H. S. Knowlton

TO THE LAYMAN the sale of by-product steam from an electric generating station may appear a very simple matter, but in reality this practice requires a good deal of engineering analysis if it is to be made profitable. With the passing of the season for building heating on a large scale in northern climates, maintenance activities will absorb attention for some time. During the summer it may be advantageous to review the experiences of the past winter where steam has been sold on a by-product basis, and to check over the costs involved as a guide to sound operation next fall. The sale of by-product steam for processing in industry is often not a seasonal job, but as the peak load on steam supply lines generally includes space heating for occupants of buildings, the coming months offer many plant engineers an opportunity to put their economic houses in order which is not available in colder weather.

Too many organizations selling steam are not in possession of reliable data on overall costs of this service. A careful inventory of the physical plant required to render such service is essential to a proper computation of overhead costs which cannot be neglected in any suitable analysis. This may involve allocating boiler, auxiliary, pipe and conduit costs between electrical and steam service on a revenue basis, on a heat unit basis or both. The operating engineer should be able to exhibit costs for more than one set of conditions in order to guide his executives to sound decisions when need arises for determining policies and programs. These can be computed with reasonable accuracy if the equipment and first costs concerned in steam delivery are segregated from data for the rest of the plant on a common-sense basis. Pleas of ignorance as to these costs do not reflect credit on an operating man responsible for handling this service successfully and so far as possible keeping it "out of the red."

The value of periodic studies of steam service cost is well illustrated in the case of an eastern steam plant which sold steam and electricity to a college in the same community. The management of the plant was liberal in investing funds in instruments for checking up the temperatures and volumes of steam sent out and returned as condensate. It was found that more condensate in volume was returned to the power plant than was sent out to the various buildings in the form of steam equivalent. The steam plant stood to owe the college money instead of to collect it for service. An investigation showed that in connection with the erection of a new chemical laboratory someone had seized the opportunity to connect the waste piping of the establishment with the return line of the heating system. Conditions like these may not often arise, but an engineering audit of costs and operating methods may accomplish much good if combined with periodic maintenance activities.

Heat Transfer *from* Finned Engine Cylinders

By ARNOLD E. BIERMANN and BENJAMIN PINKEL
N.A.C.A. Laboratories, Langley Field, Va.

COOLING OF CYLINDERS by means of metal fins exposed to an air stream can be treated as two related problems, one involving the convection of heat from the fin surfaces by the air stream and the other involving the conduction of heat through the fins to the fin surfaces. The work reported was part of a general research program by the National Advisory Committee for Aeronautics to supply information for the design of fins for air-cooled engine cylinders operating in a free air stream.

In this respect it was considered desirable to: Compare the relative advantage of different fin shapes; obtain experimental values of the surface heat-transfer coefficient for a variety of conditions of fin shape, width, thickness, and spacing for a wide range of air speeds; derive a method of calculating the quantity of heat dissipated from finned cylinders; develop a method of determining the fins having a maximum heat transfer for any given expenditure of material.

A group of 18 steel cylinders having inside diameters of 4.5 in. and wall thickness of 0.08 in. were selected for testing. The designation "0.25-0.67-0.04" indicates a finned cylinder having a fin pitch of 0.25 in., a fin width of 0.67 in., and an average fin thickness of 0.04 in. All the fins having a thickness of 0.04 in. were rectangular in cross section; the other fins were tapered. The radius of all the fin tips was 0.02 in.

Tests were conducted at approximately constant heat input for each finned cylinder and at air speeds ranging from 30 to 150 miles per hour. The heat input for the 18 cylinders ranged from 23.4 to 101.3 B.t.u. per sq. in. of outer cylinder-wall area per hour.

Average surface heat-transfer coefficients q were obtained by dividing the total heat input per hour by the product of the total cooling surface area and the average temperature of the entire cooling surface. The term "temperature" as used here refers to the temperature difference between the heated surface and the cooling air. An approximate q for individual stations around each cylinder was obtained by dividing the total heat input per square inch of total cooling surface area by the average surface temperature at each station.

Increase in fin width up to about 0.40 in. results in an appreciable reduction in the value of q; whereas for a further increase in width the variation in the value of q is much smaller. As most fins of practical interest have a width greater than 0.40 in. it may be assumed for purposes of calculation that q is independent of fin width.

For closely spaced fins the mutual interference of the boundary layers of adjacent fins restricts the air flow and results in a small surface heat-transfer coefficient. As the fin spacing is increased the interference decreases and q increases, until a point is reached where the flows over adjacent fins no longer interfere and q approaches a limiting value.

Curves representing an average of all the surface heat-transfer coefficients determined in the tests are shown in Fig. 2 plotted against the average air space, s, between adjacent fins. These curves represent tests on rectangular and tapered fins of various thicknesses, widths and taper angles. The average deviation of the test points from the curves is less than 8 per cent, showing that the most important fin dimension governing the value of q is s and that the effect of variations in the other dimensions is small. For

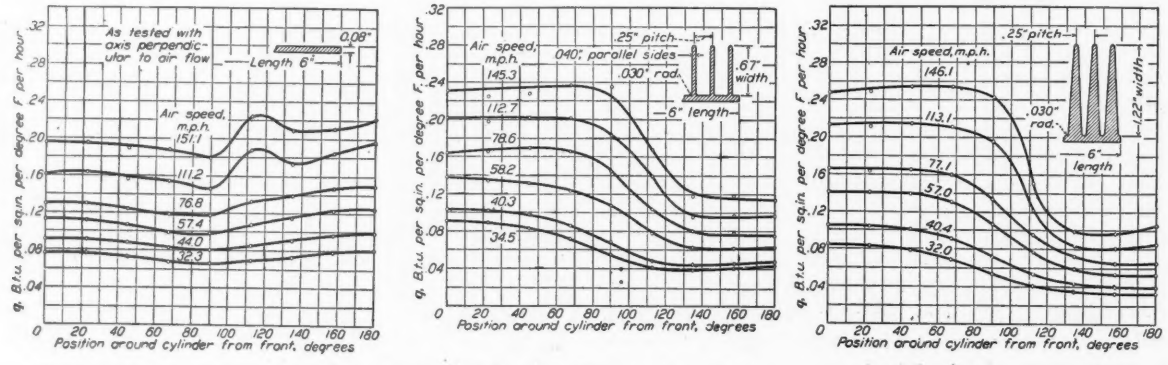


Fig. 1. Variation of q with position around the cylinder at different air speeds, for a smooth cylinder and two types of fins.

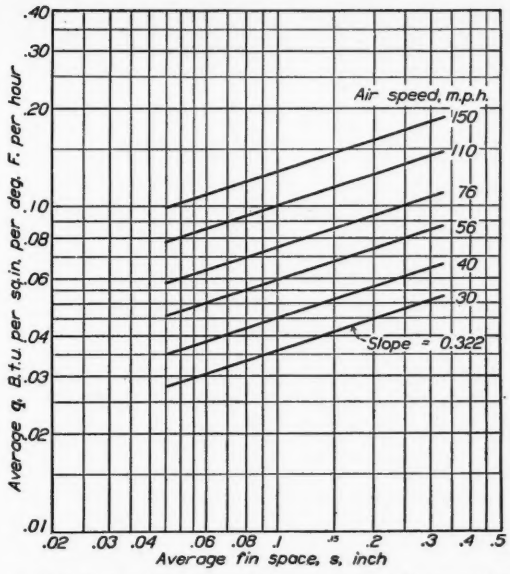


Fig. 2. Variation of average q with the average fin spaces for all cylinders tested.

the range of spacings tested the value of q varies with the 0.322 power of s.

For a given value of s, variation in fin thickness does not have an appreciable effect on the air flow. Sufficient data were not collected to determine the independent effect of fin thickness except that it was found to be of minor importance in determining the value of q. For instance, the 0.25-1.22-0.09 and the 0.3-1.32-0.13 cylinders have approximately the same fin space, the first having a thickness of 0.09 in. and a width of 1.22 in. and the second a thickness of 0.13 in. and a width of 1.32 in. In spite of these differences, the value of q at 76 mi. p.h. for the first-mentioned finned cylinder is 0.091 and for the second is 0.087.

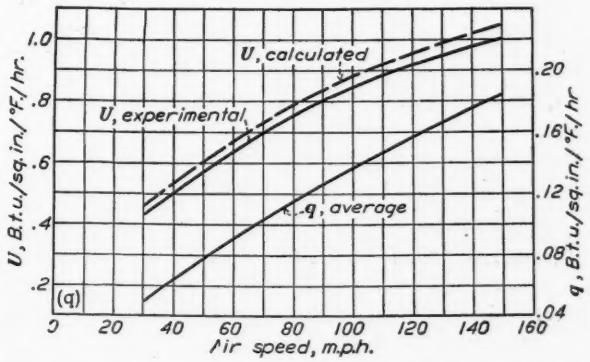
The surface heat-transfer coefficients from Fig. 2 when plotted against velocity on logarithmic coördinates for a space of 0.175 in. shows that the value of q varies with the 0.796 power of the velocity. This exponent holds fairly well for the range of fin spacings tested. For very close spacing a transition point is indicated at low velocities.

Values of q have been considered thus far in terms of the average for the entire cylinder. As the air flow varies over different portions of the fins, the value of q necessarily changes from point to point. Values of q at individual points around the cylinder are shown in Fig. 1 together with a section view of finned cylinders tested.

These values are not the true q's for the individual positions around the cylinder, as in their determination no account was taken of the circumferential heat flow through the fins and cylinder wall. However, for approximate calculation this uncorrected value is probably of more use than the true value, since for a given cylinder it allows the calculation of the heat dissipated from the given point on the cylinder directly from the heat-transfer equations without necessitating a determination of the circumferential flow through the metal. When this coefficient is applied to fins of another cylinder at a similar point on the circumference, it will be in error by the difference in the circumferential heat flow for the two cylinders. The error involved, however, is sufficiently small to permit the use of the coefficient for estimating the heat dissipated from various positions on the cylinder.

Values of q presented apply only to a cylinder diameter of 4.66 in. and an air density corresponding to sea-level conditions. The value of q can be determined for other cylinder diameters and air densities by use of the theory of similitude. The value of q is a function of the air flow around the cylinder and depends upon the constants of the fins only insofar as they influence the air flow. It is evident, therefore, that the values of q presented in this report hold also for fins constructed from materials other than steel.

By equating the heat conveyed from the surface



(q) Cylinder 0.25-1.22-0.04.

Fig. 3. Variation of average q with air speed and comparison of calculated and experimental values of U. It should be noted that q and u are entirely different coefficients. Q is surface heat-transfer coefficient, B.t.u. per sq. in. of total surface area per hour per deg. F. temperature difference between the surface and the cooling air. U is the over-all heat-transfer coefficient, B.t.u. per sq. in. of base area per hr. per deg. F. temperature difference between the cylinder wall and the cooling air.

of a fin by the air stream to the heat transmitted to the surface by conduction through the fin, a differential equation may be obtained, the solution of which leads to an expression for calculating the heat dissipated from finned cylinders as a function of the surface heat-transfer coefficient, the fin dimensions, and the average temperature of the cylinder wall.*

As a result of the work, several conclusions may be enumerated: 1. The value of the surface heat-transfer coefficient varies mainly with the air velocity and the space between fins. The effect of the other fin dimensions is small. 2. The ratio of the maximum to the average cylinder-wall temperature difference for cylinders having fin pitches from 0.10 to 0.30 in. was found to be approximately 1.35. 3. The theoretical formulæ developed for calculating the heat dissipated from finned cylinders check fairly closely the heat dissipation determined experimentally. 4. For the range of fins investigated the smaller the allowable thickness and space between fins, the more efficiently can the fins be designed from a weight consideration.

*Editor's Note: Development of these equations with detailed examples showing calculations with different metals and cylinder diameters is given in the original N.A.C.A. Report 488 which may be obtained from the Superintendent of Documents, Washington, D. C., for 10 cents.

The Quadrature Oscillograph—

An Electromechanical Device with Two Degrees of Freedom*

By JESSE B. SHERMAN
Colen-Gruhen, Inc., New York, N. Y.

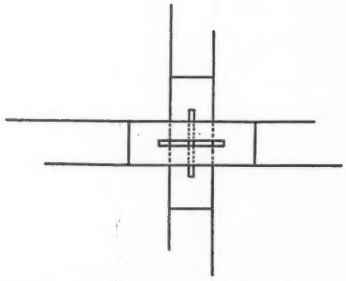


Fig. 1. Arrangement of masks

DURING THE COURSE of the design and construction of mechanical oscillograph galvanometers, a survey of the literature disclosed the lack of a suitable galvanometer capable of two deflections in space quadrature. Such an instrument would afford the possibility of constructing an electromechanical oscillograph for power frequency work, in which the rotating or oscillating mirror is replaced by a self-synchronizing sweep circuit applied to the horizontal deflector. The conventional mechanical oscillograph with variable speed mirror is difficult to use for observation of phenomena not of constant frequency, and the use of a synchronous motor to drive the mirror limits decidedly the frequency range of the apparatus. A mechanical galvanometer giving quadrature deflections overcomes these limitations and provides as well the means for producing Lissajous figures, hysteresis and other loss loops, and other two-coördinate figures. This is in effect a low-frequency substitute for the cathode ray tube.

The direct projection method of the Einthoven galvanometer is employed, using longitudinally bored poles and optical magnification by means of a projecting microscope. However, instead of projecting the shadow image of a vibrating string, a slitted mask mounted on parallel strings permits restricted passage of light. One such mask when stationary will produce on a viewing screen a straight line of light on a dark field. Two slitted masks, one on each vibrator, with their planes parallel to each other and with their slits at right angles, will produce on the screen a square spot of light resulting from the intersection of the two slits. This is indicated in Fig. 1.

If either vibrator alone moves under the application of an alternating electromotive force, a bright line will be traced on the screen in either the horizontal or the vertical direction. The movement of both vibrators will result in the production of Lissajous figures precisely as in other cases of quadrature vibrations.

A rugged vibrator used in a galvanometer intended for sixty cycles has a suspension of two parallel tungsten wires 0.05 millimeter in diameter and seven centimeters long, separated one millimeter. The mask is of aluminum foil, three millimeters long, with width equal to the separation of the wires. The mask is bent around the wires and cemented to them. A slit approximately 0.0065 millimeter wide (measured by microscopic examination) allows the passage of light as already mentioned.

Figure 2 shows the complete suspension holder. It is removable as a unit from the field structure. Adjustments are provided for lateral movement of both horizontal and vertical suspensions for the purpose of centering the slits.

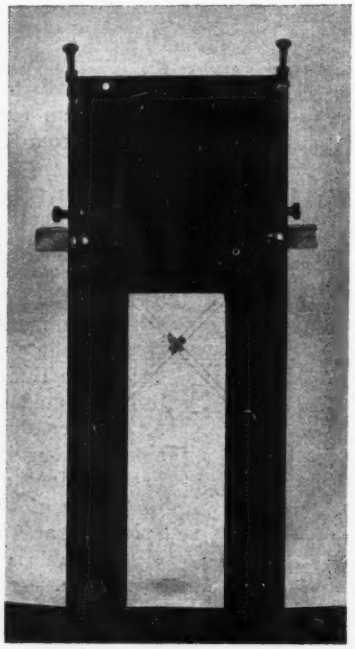


Fig. 2. Suspension holder.

The horizontal and vertical suspensions are so spaced that the masks have a clearance of approximately 0.8 millimeter. This spacing is sufficiently small to allow focusing of the microscope on both slits without excessive "fuzziness" of the spot, and at the same time provides an adequate clearance of the suspensions.

As used on sixty cycles, the suspensions are given a free period of about 1000 cycles. By the use of a calibrating voltage to which both vibrators may be connected, the tension and hence the period and sensitivity of both vibrators can be made very nearly alike. A free period of 1000 cycles is sufficient to include the effect of the seventh harmonic with reasonable accuracy. In order to avoid

*A paper presented to the Institute of Radio Engineers and reprinted from the April 1935 Proceedings of the IRE by special permission.

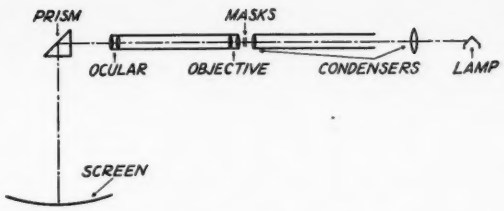


Fig. 3. Optical System.

exaggeration of any particular harmonic it is necessary to avoid harmonic points in tuning the suspensions; this, because of the sharpness of resonance of an air-damped vibrator, is not difficult.

Figure 3 shows the optical system used. By mounting the prism on a universal joint operable from the panel, small movements of the spot on the screen can be made optically without the necessity of actually moving the suspensions. Focusing of the microscope is accomplished by a rack and pinion likewise controlled from the panel.

With over-all optical magnification of 250, the spot is approximately 1.6 millimeters square. The practical limit to magnification is fixed by the minimum feasible width of the slit in the mask. Using a small 50-watt projection lamp, the spot is readily visible in a moderately lighted room. No attempt has been made to incorporate recording equipment; the problem however does not differ from that of other oscilliographic apparatus.

With a gap density of approximately 30,000 lines per square centimeter, the current sensitivity at sixty cycles with suspensions tuned to 1000 cycles in 0.017 amp. per millimeter half amplitude. This represents a power sensitivity of 6×10^{-4} watt per millimeter, the resistance of the suspension being two ohms.

Figure 4 shows the complete circuit diagram. A "universal" power unit is provided for the galvanometer field so that the apparatus may be connected to either an alternating or direct-current source. Adjustments are provided for amplitude of both horizontal and vertical deflections. A single switch permits both vibrators to be connected either to a calibrating voltage or to the sources under investigation. An ammeter may be thrown into either vibrator circuit by means of another switch.

Figures 5 and 6 show the complete apparatus with projection lamp mounted on the side of the cabinet. Referring to Fig. 6, the galvanometer unit may be seen with one condensing lens at its right and the projecting microscope with focusing mechanism at its left. To the left of the microscope is the prism and on the panel in front of the prism is the ground-glass screen. The field supply with rectifier tube is at the left of the galvanometer unit. The complete apparatus measures approximately 19 by 10 by 10 in.

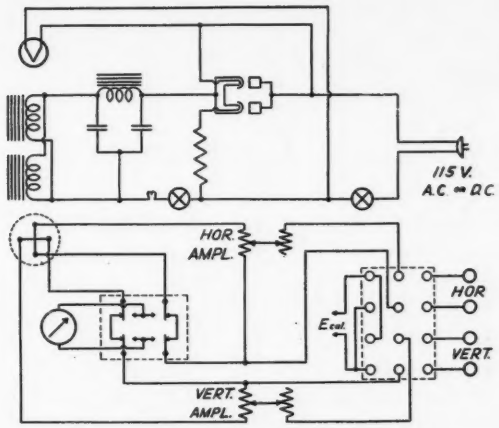


Fig. 4. Schematic wiring diagram circuit.

This instrument is not to be thought of as a substitute for the cathode ray oscillograph except in the case of low frequency work.

Fig. 5. Front view of apparatus.

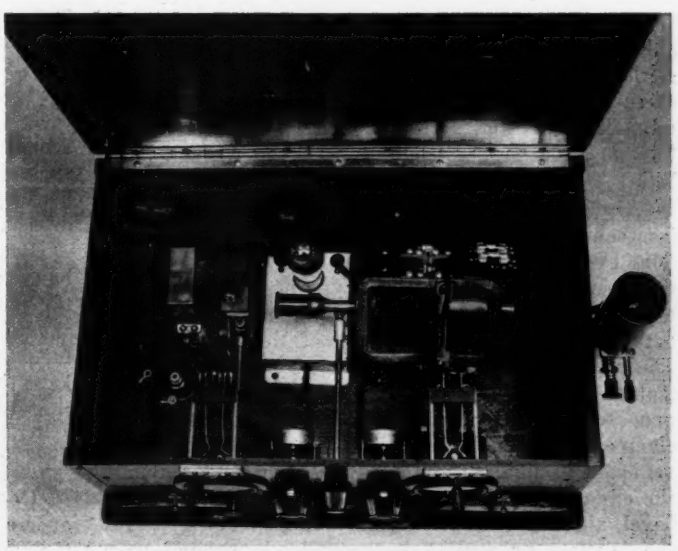


Fig. 6. Inside view of apparatus.

Care *of* Direct Current Motors *and* Generators

MUCH HAS BEEN said and written about the care and operation of direct current motors and generators. This discussion has centered largely about the current collecting and distributing parts, i.e., the commutator and the brushes, because most of the operating difficulties in equipment of this kind occur in these parts. Indeed, the problem of commutation and of current collection through sliding contacts is imperfectly understood and only in recent years have any serious studies been made of this phenomena. In this article we will not concern ourselves with the theory of commutation but with the practical care of the commutator and brushes as well as with other aspects of direct current machinery maintenance. The material which is presented here appeared in a recent article by C. Lynn of the Westinghouse Electric and Manufacturing Co. in the Electric Journal and while the methods described are not new or unusual, they should be thoroughly understood by every operator of direct current machines and for these reasons we repeat them here. Electrical machinery in contrast to practically all other moving devices, will normally run for years without any attention whatever, but this does not imply that a reasonable amount of care and attention will not add to the life of such equipment. This is particularly true of direct current machinery involving sliding contacts between brushes and commutator.

Commutators should present a true and smooth surface for the brushes to ride upon. This means an occasional commutator conditioning. Smaller size commutators can be turned in a lathe, but for medium and larger sizes, a better procedure is to grind them with their shafts in their own bearings, operating preferably at their rated speed or slower. There are two methods of doing this: use of the stationary type stones or revolving stone grinders. In either case the stone is moved back and forth across the commutator surface on a sliding rest similar to that of a small lathe bed.

After the grinding, the mica should be undercut between the bars for 1/16 in. This cutting should be done even on the older type machines, which had soft mica, so that a more modern type of brush can then be used. Care must be taken to get all the mica out between the bars for the depth of the undercutting. The undercutting can best be done by a small circular motor- or air-driven saw designed especially for this purpose or with a section of a heavy hacksaw blade clamped between two small wooden pieces for convenience in holding the blade. After undercutting, the edges of the bars should be given an appreciable bevel, about 1/32 in., with a triangular tool made for the purpose or with a hacksaw blade ground as a "hooked-knife." The commutator can then be polished with alauxite or sandpaper, never with emery cloth. A burnish can be secured by applying a light-grade oil to a piece of canvass and pressing it up against the revolving commutator. High-speed commutators, that is, those having peripheral speeds about 4000 ft. per min., should be ground true within 0.001 in. when operating at rated speed. Slower speed commutators can of course operate with greater eccentricity. High-speed commutators in severe service might require a grinding as often as once a year, although most commutators of this class require less frequent attention. Slow-speed commutators may operate for many years without a grinding.

Brushes

The choice of the best brush for any particular machine is a matter of experience, usually based upon the combined experiences of the manufacturer of the machine and the operator. Brushes can be divided into two general classes, electrolytic and the softer graphite type. Both kinds give satisfactory service.

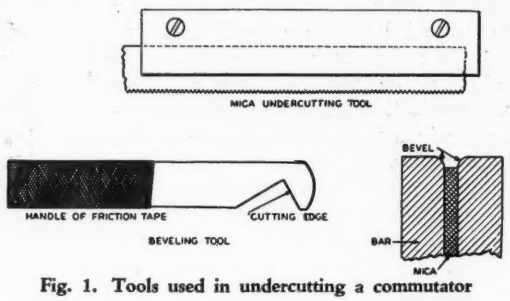


Fig. 1. Tools used in undercutting a commutator

Brushes when first fitted to a machine should be ground in to fit the curvature of the commutator. Replacement brushes should be treated likewise. This can best be accomplished by a strip of narrow sandpaper pulled between the brushes and the commutator surface in the direction of rotation of the commutator. The brush should be lifted on the return stroke so as not to obtain a double fit on the brush face. The sandpaper should be held to the curvature of the commutator surface; otherwise the edge of the brush will be rounded and subject to sparking.

Brushes must be free to move in their holders, and the shunts should not be bent over as this will prohibit their free movement. The springs or spring levers should rest evenly on the tops of the brushes, and the spring pressure should be approximately even on all brushes, of a value recommended by the manufacturer or as found best by experience.

Brushholders must have smooth interiors in the boxes and should be lined up evenly and parallel to the commutator bars. The bottom of the brushholders should be within 1/8 to 1/16 in. of the commutator surface. All connections of the brush rigging should be kept tight and clean to give even distribution of current between all arms.

Cleaning

Good maintenance requires cleaning of the machine once a week and includes, as a minimum, blowing out the machine with compressed air, seeing that all brushes are free in the holders, replacing all worn out

brushes, and wiping off with a cloth the metal parts of the machine.

Since oil is detrimental to mica and machine insulation, care should be taken that it does not come in contact with these parts. Oil in the mica of the commutator will cause carbonization and eventually lead to breakdown between commutator bars or between commutator bars and steel parts of the commutator. Oil on the windings, besides deteriorating the insulation, will cause dirt and carbon dust to adhere to the windings, especially to the under portions, which cannot be blown or cleaned easily. This dirt and carbon dust will form a conducting path of some resistance

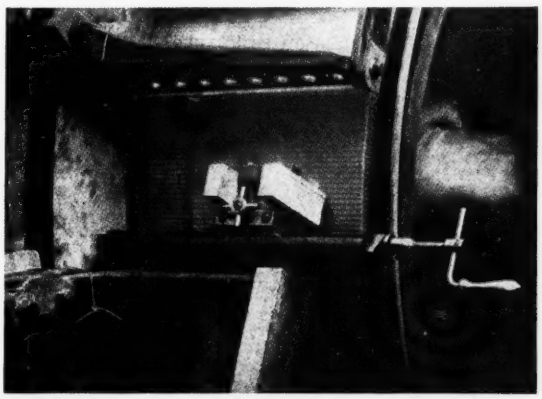


Fig. 2. Grinding a commutator with a device using stationary type stones. By turning the crank at the left the stones move across the face of the commutator. To avoid any possibility of vibration the device is usually well braced with wooden supports as shown here

which, when the resistance becomes low enough after a heavy deposit, will cause failure of the insulation from the leakage currents flowing through this path. Breakdowns of this nature generally occur on the under side of the armature coils near the commutator necks. Where this condition is encountered, trouble may be averted by a thorough cleaning of the machine with a solvent such as carbon tetrachloride, either undiluted or mixed with gasoline. After such a cleaning or after a seasonal thorough cleaning, the application of insulating varnish to the windings of the machine is good insurance. The condition of the insulation can in a measure be determined by megger readings. Operation at low megger readings is permissible and without much accompanying danger if readings repeated over a considerable period of time do not indicate a further reduction of the insulation resistance.

ENGINEERING FOUNDATION has appointed a Welding Research Committee to (a) initiate and conduct a critical review of world welding literature, (b) to render modest aid to worthy individual projects functioning under the Fundamental Research Committee of the American Bureau of Welding, and (c) to sponsor specific research investigations. The project will be started by funds contributed by Engineering Foundation supplemented by funds and services supplied by industry. The project is jointly sponsored by the American Institute of Electrical Engineers and the American Welding Society.

Annealing Pipe Welds *by* Induction

A. P. Frugell and D. H. Corey of the Detroit Edison Co. Tell A.W.S. of the Development and Advantages of 60 Cycle Induction Heaters for Stress-Relieving Welded Pipe Joints

IT IS OFTEN DESIRABLE to stress-relieve fusion welds in a pressure piping system. To relieve, properly, welding stresses in a circumferential pipe weld, the weld and a length of pipe on each side of it equal to about six times the wall thickness should be heated to a comparatively uniform temperature of 1100 to 1300 deg. F. which should be maintained for a period of time equal to 1 hr. for each inch of pipe wall thickness.

A convenient and satisfactory method of accomplishing this stress-relief by an application of electric induction heating in the pipe has been developed by The Detroit Edison Co. In the course of this devel-

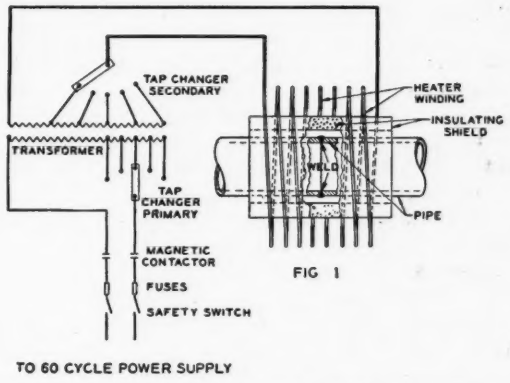


FIG 1

Schematic arrangement of equipment used for annealing welds

opment, a large number of experiments was made on pipe from 4 to 16 in. in diam. In addition, about sixty welds in pipes ranging in size from ½ to 8 in. were stress-relieved by this method under conditions duplicating those in central-station power plants.

The general scheme is quite simple, consisting merely of wrapping several turns of a conductor around the pipe directly over the weld and passing 60-cycle current through this winding. A moderate amount of heat insulation is used between the heater winding and the pipe to protect the winding from the heat in the pipe. The mechanics of designing a winding which could be placed around the welded joint conveniently after the pipe was installed; of obtaining heat insulation of correct mechanical properties which would stand the high temperature; of determining the proper electrical characteristics of the heater winding; of obtaining a winding which would provide sufficient ampere turns without exceeding the permissable temperature or requiring too much space, was more in-

volved and required considerable experimentation. Figure 1 shows the schematic arrangement of equipment as evolved, with the major electrical wiring connections.

For the original experiments, conventional heat insulating pipe covering was placed around the pipe and, over this, copper tubing was wrapped until the required number of turns was obtained. The tubing was wrapped with insulating tape to provide turn-to-turn insulation and water passed through the tube to provide the necessary cooling. Though satisfactory results were obtained, the installation of the equipment was rather awkward and would be even more so during actual service. Hence, for actual use in the field, an insulating shield of heat-resisting material held away from the pipe by steel rings and a self-cooled heater winding cut from plate copper or aluminum were constructed. Both shield and winding were hinged so that they could be opened to slip over the pipe and then closed and bolted into place ready for operation. One winding was used for two sizes of pipe by making a different insulating shield for each pipe size.

Variable Voltage

As stated previously the power supplied to the winding can be obtained from any 60-cycle power circuit of sufficient capacity but the voltage should be variable over a considerable range in comparatively small steps. In the first place, since both the ampere turns and the voltage per turn for unit current in the heater winding, increase with the pipe diameter, it is practically impossible to design heater windings for a wide range of pipe sizes, all of which will operate at the same voltage. Furthermore, even for a given diameter of pipe and a given heater winding, the proper current and voltage depends upon such variable conditions as the wall thickness, the heat radiation from the pipe and the length of leads to and from the transformer.

Even with these conditions maintained constant, the ampere turns required to reach a final temperature of 1100 to 1300 deg. F. give a comparatively high initial rate of temperature rise, so that it is desirable to change the number of ampere turns during the heating cycle. The most convenient method of satisfying these requirements is to vary the applied voltage. As indicated in Fig. 1, this was accomplished by using a transformer with sufficient taps to give the required voltage steps. The transformer used was rated at 75 kv-a., 230 v. primary, with taps to give secondary voltages from 11 to 107 v. in 25 steps, each step giving a voltage about 10 per cent higher than the preceding one. This equipment can be used to stress-relieve welds in any pipes up to 16 in. in diameter. For larger pipes both more kv-a. and higher secondary voltages would be required.

Figure 1 also shows a magnetic contactor to energize the primary of the transformer and hence the heater winding. After the pipe has reached the required temperature, it is maintained within the desired limits by the operation of this contactor. This can be done by hand but it is much more satisfactory if the control is automatic. Therefore, a recording-controlling potentiometer operating from a thermocouple at the weld is used to control the operation of the magnetic contactor to maintain the temperature within the desired limits.

In order to make the auxiliary equipment readily available to the location where the welding is being done, the transformer, tap changer, contactor, line safety switch, control equipment and potentiometer are all mounted on a hand truck, with long primary and secondary leads.

Close Control

During the short time The Detroit Edison Co. has stress-relieved pipe welds by means of 60-cycle electric induction, both the method and the equipment developed have proved most satisfactory. Minor changes can undoubtedly be made in the equipment as further use shows up limitations, but it is believed that no major modifications will be necessary.

The weld temperature measured at any single point can be maintained within 20 deg. F. of the desired temperature with automatic control. The maximum point-to-point variation in temperature which results from such conditions as differences in surface radiation, has been found to be approximately 50 deg. F., for the larger sizes of pipes used, that is, 12 to 16 in. The variation is less for the smaller pipes. The precision in temperature control precludes any danger of changing the nature of the grain structure by exceeding the critical temperature of the metal.

The points in favor of this method may be listed as: The equipment, though somewhat bulky for the larger pipes, can be used wherever there is sufficient clearance around the pipe to do a satisfactory welding job; the time required to put the equipment in place ready for operation depends on local conditions but is moderate in all cases; power supply to the heater winding may be obtained from any 60-cycle circuit of sufficient capacity; the energy required varies with the size of pipe but is small in any case. For instance, stress-relieving a weld in a 2½-in. pipe required 3 kw-hr., in an 8-in. pipe 13 kw-hr. and in a 16-in. pipe 27 kw-hr.; the method is far cleaner and produces much less waste heat than fuel-fired devices; the method assures flexible, yet precise, heat control and within reasonable limits the rate of heating may be varied at will.

On September 1, a permanent exhibit of metals and plastics will be opened at Rockefeller Center, New York, by Metal Products Exhibits, Inc.

The exhibition will be devoted wholly to the interests of those who specify and purchase materials and parts for industrial purposes. It will feature alloys, ferrous and non-ferrous metals, plastics, finished and semi-finished parts made from these materials, finishes for metals and plastics, manufacturing processes, designs, styling, etc. It will occupy the third floor of the International Building, the latest addition to the Rockefeller Center building program.

"The need for a comprehensive and permanent exhibit of metals and plastics has long been apparent," stated Herbert R. Simonds, vice-president and general manager of the Exhibits Company. "Hundreds of these materials are now available to industry, in the widest variety of properties and finishes, and each is especially suitable for use in manufacturing certain products.

Profitable Air Conditioning

Types of Systems and Units to be Considered, Effects of Design Features on Economy, Climatic and Occupational Conditions Are Factors in Cost Analysis.

By R. B. REGAN*

MUCH HAS been published as to the benefits of air conditioning in comfort gain and in industrial economy. The former is unquestionable; the latter may be more alluring than assuring, due to failure to make proper analysis as to feasibility, best equipment and cost of operation and overhead. Enthusiasm of the inexperienced for selling a job should not be allowed to overbalance seasoned judgment or the advancement of a promising industry will be checked by the record of failures to produce the estimated results for the owner who has invested in the plant.

Sufficient data as to costs and performance are available so that accurate analysis of any problem can be made of the probability of the success of any proposed installation as a profit maker, also what type of installation is most suitable for the purpose proposed and the conditions to be met. The plant may be a central installation with automatic control, distributing air to various rooms by fan as required, with temperature and humidity regulated partly at the central plant and partly at the room; or the heating and cooling effect may be distributed by hot water and brine coils to the various rooms, air circulation being controlled locally; or the room unit may be used, both heating and cooling being by an individual unit for each room, with a fan for air circulation at each unit. More commonly the heating will be by a central plant from which steam, hot water or hot air are distributed. Cooling for a new building will most likely be central, but for a remodeled plant in an old building, the room installation for cooling may prove better because of the greater convenience of installation and the less expense for cutting and patching for pipes and ducts. In any case, either ice cake cooling or mechanical refrigeration may be involved according to the size of the installation and the cost of operation.

The central plant will require space for equipment and throughout the building for ducts, with provision for proper discharge of the conditioned air. On the other hand, the placing of the conditioning equipment in a room is often inconvenient, involves greater work for care and upkeep and will not, as a rule give as good conditioning. Also the noise of the unit in the room may be found objectionable. Where cooling is required for only a few weeks in the year, the room unit with ice cake cooling may likely be the most economical, as a temperature reduction of only 10 to 12 deg. below the atmosphere is usually sufficient to insure comfort and 85 lb. of ice melted per hour will give as much cooling effect as one ton of refrigeration plant, working for the same length of time. For a long cooling season or large installations, the central plant with mechanical refrigeration is almost certain to be preferable.

*Air Conditioning Engineer, Elizabeth, N. J.

Points for Consideration

While experience has resulted in the ability to produce great flexibility of a conditioning system, cost of installation and operation of the refrigeration equipment is still high because of the heavy machinery and foundations needed. Noise in the distributing systems is still difficult to overcome and it is doubtful if some of the proposed sound absorbers used for linings and insulation of ducts are justifiable. The best preventive seems to be low velociity of air in the ducts and low speed machinery, which, in turn, increases the cost and bulkiness of the installation.

Water as a cooling agent for the refrigeration condenser or for the conditioned air is in some cases costly as well as requiring large space for equipment.

Control of room conditions is often complex and involves a complicated hookup of equipment that is dismaying to the operator. A much simpler system may often be devised, using partly automatic and partly manual control, which, on the whole, will involve less labor and expense of upkeep than the completely automatic system.

Room Units

These are suitable for plants where only part of the building requires air conditioning, as where offices alone are to be cooled for comfort or some special process of manufacture calls for regulation of humidity and temperature. The units may be of floor or wall type, usually have coil or ice cake cooling rather than spray action, will, of course, involve some noise in the operation of the unit and have a limited range of humidity control. They can be quickly installed with but little alteration of the building and at low initial cost, but are hardly suitable for plants where a cooling capacity of 4 tons or more is required.

Cost Reduction

In planning for a plant, reducing the air per inhabitant and the number of air changes per hour to the minimum rather than following a set rule will cut the cost of the installation and of operation. Also by careful planning the rate of diffusion of the air may be increased by using higher air velocities in the ducts and outlets, where some additional noise is not objectionable and the outlets can be so arranged that no draft will be felt by the occupants of the rooms.

Minimum of cooling on days of maximum temperature will also reduce the cost of the plant and of average operation. A reduction of 5 to 7 deg. in the wet bulb temperature is usually enough for most comfort installations, although 8 to 10 deg. may be needed where inmates are exercising, as in dance halls and gymnasiums, as well as a larger circulation of fresh air than is needed where the occupants are engaged in sedentary work. Often for spring and fall, all that

is needed is circulation of fresh outside air, as that will give the required temperature and humidity in the rooms without heating, cooling or humidity regulation. This will result in a large reduction in operating expense as compared with recirculation of inside air and treatment for temperature and humidity.

Where an existing structure is so conditioned, analysis should be made of any existing ventilating system as to motors, fans, pumps, piping and ducts, their condition and possible life with a view to utilizing the present equipment as much as possible. In making an estimate of the cost of a job, the expense of cutting and patching for pipes and ducts should always be included, although it is not usually figured by the contractors for an air conditioning system. On small installations, this expense may nearly equal the cost of the plant, so that it is important that it be known in figuring the advisability of an installation.

While the comfort and advantage of a conditioning system is evident, as an investment it should show evidence of positive returns before it is justified and the requirements, cost of installation and operation and the value of the benefits should be carefully analyzed in order that the purchaser may receive satisfaction during the life of the system.

Corrective Effect of Capacitors

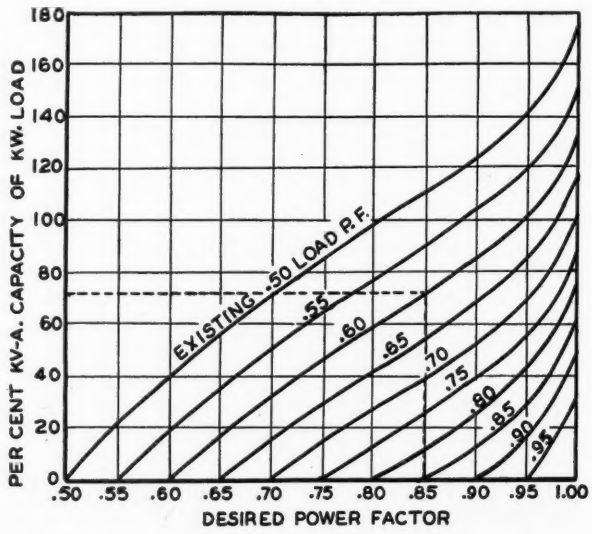
IN RECENT YEARS there has been considerable application of the static condenser or the capacitor as a means of correcting low power factor. The capacitor has many advantages in this respect over other methods. Its cost is reasonably low, it occupies small space, requires no attention and is always ready for instant action. When considering the installation of capacitors for power factor correction, however, an intelligent study of conditions should be made, not only regarding the amount of corrective kv-a. required but also as to the actual capacity in microfarads necessary to furnish the corrective kv-a. under the existing voltage conditions. As pointed out in a recent bulletin of the Aerovox Corporation, the corrective effect produced by the capacitor of given capacity is not a constant factor, but is a function of the voltage.

The following table gives the number of microfarads of capacity per kv-a. of corrective capacity when employed across a source of 60 cycle current for different voltages:

Line Voltage	Mfds. per kv-a.
110	219.
220	54.8
440	13.7
550	8.8
1100	2.2
2200	.55
2300	.5

It will be noted that as the voltage increases, the capacity in microfarads required to provide one kv-a. of corrective capacity decreases. Thus for 220 v. the capacity required for one kv-a. correction becomes one-quarter that required at 110 v. At 440 v. the capacity required is one-sixteenth that required at 110 v.

The accompanying graph gives a method of determining the kv-a. of capacitor required for suitable power factor correction. The desired power factor is followed on the curve until it intersects the horizontal line representing the existing power factor condition. The vertical projection of this intersection gives the percentage of kv-a. capacity required.



For example, suppose a system has a power factor of 70 per cent and that the kilowatt load in the system is 1000 kw. Assume that it is desired to correct the power factor to 90 per cent. From the curve it will be noted that the 90 per cent desired characteristic point intercepts the curve of 70 per cent existing power factor at a point corresponding to 53 per cent, as the percentage of kv-a. capacity required in capacitive reactive kv-a. In this case the kilowatt load is 1000 and 53 per cent is 530 kv-a. This means that if we connect across the line 530 kv-a. of capacitive load then the power factor of the system will become 90 per cent.

The capacity in microfarads required to obtain 530 kv-a. can be figured from the foregoing table.

If the system had a voltage of 1100 v. 60 cycles a.c., then the capacity required would be, from the above table, 530 multiplied by 2.2 or 1166 microfarads. On a 2300 v. circuit, however, only 530 x .5 or 265 microfarads would be necessary.

STUDY of work-payment methods in an English factory showed increase of support of 35 to 45 per cent with the bonus method over that for daily wage; also further increase of 30 per cent when piece rate payment was adopted.

IN A NEW 2-shape air compressor with air-cooled intercooler, introduced by Ingersoll-Rand Co., Ltd., of London, Eng., power consumption is stated to be 15 per cent less than for single-stage water-cooled compressors and delivered air is 150 deg. cooler.

Checking Up On The ORSAT

Correctness of combustion may be determined by comparison of fuel and flue gas analyses. Several methods are outlined in this article.

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METHODS usually employed for calculating the air ratio and excess air supplied to a furnace are based on the flue gas analysis. One method employs the nitrogen to carbon ratio in the flue gases and requires that the ultimate analysis of the fuel be known. Another requires only the flue gas analysis, and is considerably more direct. It is based on determining the excess oxygen to oxygen used ratio. The excess oxygen is determined by completing any incomplete combustion, as evidenced by presence of CO, etc., at the expense of the free oxygen as given in the Orsat analysis, and the oxygen used is determined by difference from the oxygen supplied and the excess oxygen. The nitrogen content furnishes the key to the oxygen supplied.

It sometimes happens that the two methods do not give the same result when applied to the same data. This has led to some erroneous statements in the literature, regarding the accuracy of the latter method which uses the oxygen content of the flue gases. Both methods, however, are theoretically correct, and it can be shown that they will check identically, provided the correct fuel and flue gas analyses are used. Both are based on the assumption that the gas remaining in the Orsat after complete absorption of CO_2, O_2, and CO is only nitrogen, and that this nitrogen came only from the air supplied. Error introduced under these assumptions would affect both methods and would not be a cause for their failure to check.

Whenever a heat loss analysis is made, as is often done in new installations, it is particularly desirable that the flue gas analysis be right, as the flue gas analysis is the basis for calculating several of the items. Often there appear in the literature, particularly in textbooks and references, complete heat balances accurately calculated from test data that are apparently in error in the above respect. The usual trouble is that the flue gas analysis does not check or fit the fuel analysis as given.

The relative magnitude of the constituents in the dry flue gases depends only and entirely upon the combustible constituents in the fuel burned, and upon the amount of excess air supplied for their combustion, complete or otherwise. This fact makes it possible, knowing the analysis of the fuel as burned, to detect errors in the flue gas analysis, or having an accurate flue gas analysis, to check up on the fuel analysis.

A relationship that exists between fuel and flue gases, provided that CO is the only combustible gas in the flue gases, and which is independent of the amount of excess air supplied, is:

$$\frac{8.807}{0.4213 + \dfrac{H}{C + 0.375\,S}} = \frac{(CO_2 + CO)100}{100 - 4.78\,O_2 + 1.89\,CO} \quad (1)$$

in which

H = available hydrogen in fuel, per cent by weight,
C = total carbon in fuel as burned, per cent by weight,
S = sulphur in the fuel, per cent by weight,
CO_2, CO and O_2 = constituents in the flue gas analysis, per cent by volume.

This equation is a modification of the one derived by Bato.[1] It simply expresses the maximum possible CO_2 content of the flue gases, that is, complete combustion with the theoretical air requirement, in terms of the combustible constituents of the fuel on the left-hand side, and in terms of the gases determined in the ordinary Orsat analysis on the right-hand side. Sulphur is included as contributing to the maximum CO_2, since in the usual analysis it is absorbed as CO_2.

E. H. Lockwood has worked out a similar but less useful and exact relationship to be used for checking flue gas analyses obtained from fuels whose analyses were not known.

$$CO_2 + mO_2 + nCO = k \quad (2)$$

[1] A. A. Bato, Flue Gas Computations, Mech. Engng., Vol. 48, Apr., 1926, pp. 330-6. Power Plant Engineering, page 839, Aug. 1, 1926.

where m, n, and k have the following values:

Fuel	m	n	k
Carbon	1.00	0.60	20.9
Gas Coke	0.98	0.614	20.35
Anthracite	0.95	0.63	19.52
Semi-bituminous	0.91	0.645	18.7
Bituminous	0.88	0.652	18.4

The Ostwald Combustion Triangle[2] and other similar diagrams are also available for checking flue gas analyses. All of these methods require that the fuel be uniform, at least the theoretical air requirement be supplied, and that the nitrogen content of the fuel be negligible.

Indication of Error

If the relationship expressed by equation (1) is not satisfied, either the fuel analysis does not represent the fuel as burned, or the flue gas analysis is in error or is inadequate. A representative fuel analysis requires, particularly in the case of coal, an accurate sampling procedure and an accurate ultimate analysis of the sample. Comparison with known reliable analyses of similar coal or coal from the same field is generally possible. Since the free moisture, ash, and much of the sulphur are accidental, comparison should be based on the moisture, ash, and sulphur free basis. Furthermore, only the burnable hydrogen, the carbon, and the sulphur contents of the fuel, and the amount of combustion air supplied, determine the dry flue gas analysis. Errors in the sampling of the fuel or in the fuel analysis inasmuch as it affects the flue gas analysis can often be detected.

It has been assumed that the flue gases represent all of the products of combustion, complete or incomplete. This is seldom the case; some unburned carbon is always discharged along with the cinder and fly ash, and an appreciable portion sometimes leaves the furnace in the form of soot. Grate droppings may include hydrocarbons as well. Assuming only carbon losses the effect as far as flue gas analysis is concerned, is that of burning a fuel having less total carbon. Flue gas sampling is just as important as fuel sampling, particularly in the case of a heat balance determination.

Ordinarily the Orsat is equipped to determine volumetrically, CO_2, O_2, and CO. In order to minimize the possible inaccuracy due to solubility of the gases in the displacing fluid, a saturated brine solution, or even mercury is used where accuracy is desired. At least four passes are usually required to absorb all of the CO_2 with the usual caustic potash solution. Any SO_2 present will be absorbed as CO_2, due to the great affinity of SO_2 for water, however, a great portion of the SO_2 will be missing from the flue gases, having been absorbed by the water of condensation. Six or more passes are usually required to complete the absorption of the O_2 with a reasonably fresh pyrogallol solution, and while the absorbing capacity of caustic potash for CO_2 is very large, that of pyrogallol for O_2 is decidedly limited. The cuprous chloride solution is the least satisfactory of all, and unless the CO is present in very small amounts, it cannot be determined satisfactorily in the ordinary Orsat without frequently changing the solution. With coals, unless burned under extremely unfavorable conditions, the CO is usually small and the ordinary Orsat quite satisfactory. Furthermore, the CO represents the bulk of the combustible gases, any hydrogen and hydrocarbons if present at all, being considerably less. With oil or gas fuel, however, the CO is not a good measure of incomplete combustion, for hydrogen and hydrocarbons appear in greater proportions as the theoretical air supply is approached.

For the measurement of these, and for the cases where the CO is high, a modified and more complete Orsat gas analyser is necessary. The hydrocarbons most likely present are methane or CH_4, and ethylene or C_2H_4, these being the most stable of saturated and unsaturated series respectively. The ethylene is first removed with fuming sulphuric acid, and the CO, H_2, and CH_4 are burned with a measured volume of air and the volume of each is computed.

As previously pointed out the relationship between the combustible constituents of the fuel and the dry flue gases as expressed by equation (1) does not allow for incomplete combustion except as CO. Hence, if the formula is applied to cases where incomplete combustion of the fuel occurs other than as CO, the lack of agreement should be evidenced of such incomplete combustion provided of course, the rest of the analysis is correct. For instance, an appreciable carbon loss in the cinder or soot, and not corrected for in the analysis, would result in the maximum CO_2 as calculated from the fuel to be higher than that calculated from the flue gases. Also a CO loss not detected in the gas analysis because of a depleted cuprous chloride solution, would be detected in this calculation; the right-hand side being lower than the left-hand side. Losses due to hydrogen and hydrocarbons not detected in the ordinary Orsat, result in the right-hand side being higher than the left-hand side, that is, opposite to the effect of the CO and carbon losses. It is possible that a combination of these losses would result in agreement between both sides of the equation, and so go undetected, however, this is not likely to occur in continuous operation, and with the usual fuels. In most cases the equation offers a quick and reliable check on the accuracy of fuel and flue gas data.

[2] Combustion Triangle and Soot Formation, Mech. Engng., Vol. 56, Oct., 1934, pp. 618-21.

Insurance Rules Modified

For policies on boilers and machinery, covering property damage and personal injury, written after May 1, 1935, the Standard policy of the National Bureau of Casualty and Surety Underwriters is to have more liberal form. Limit per person for personal injury will be removed, the limit of liability, whether for one or more persons being the amount of the policy less any payment for direct property damage. Coverage for personal injury will apply to both employes and the public except as to liability under workmen's compensation laws in various states. Personal injury liability will be construed to cover loss which may not be covered in other liability insurance. Expediting Charges, to cover expense of hastening repair of damaged property such as overtime and express charges are modified so that the limit is $1000 unless property damage loss is over $1000, then the limit is $1000 plus 25 per cent of the excess of the loss over $1000.

Acid *Before and After* Zeolite

By RAYMOND DAVIS*

WHEN A ZEOLITE softener is used for waters that have low non-carbonate hardness, it is sometimes necessary to supply additional sulphates in order to realize the ratio of total alkalinity to sodium sulphate as recommended by the A.S.M.E. Boiler Code Committee for the prevention of so-called "caustic embrittlement" in steam boilers. The most economical method of accomplishing this at present is to treat the water with sulphuric acid whereby the alkalinity is reduced and sulphates increased with a single reagent. By taking into account certain precautions set forth in this article, the acid may be added to the water either before or after it passes the zeolite sand and the full benefits realized.

It is the opinion of many that the ultimate results are the same so far as reduction of alkalinity of the makeup water is concerned, whether the acid is added before or after the zeolite softening process. This is true only when the water, if pre-treated with acid, is thoroughly aerated before it reaches the zeolite sand so as to remove the free CO_2 generated as the result of adding the acid.

When we first started to operate a zeolite softener and pre-treatment with sulphuric acid it was noticed that the alkalinity of the boiler water built up much faster than was expected in view of the amount of acid used and the residual alkalinity of the water going to the zeolite. Subsequent tests were made to determine why one purpose for adding the acid was being largely defeated. The well water then in use for boiler feedwater makeup had the following analysis:

	Parts per million
SiO_2	24.8
Fe_2O_3	1.2
Ca	72.8
Mg	6.0
HCO_3	247.0
Cl	18.0
SO_4	32.6
NO_3	17.7
K and Na (As Na)	34.6
Total Alkalinity (As $CaCO_3$)	203.0

Figure 1 shows hourly alkalinity tests of run following the regular procedure of back-washing and rinsing with raw water; Fig. 2, when rinsing, draining and filling with acid treated water; and Fig. 3, when rinsing with acid treated water. High alkalinity of the effluent water at the start of each run was common for every test regardless of the back-washing and rinsing procedure. This alkalinity did not approximate that of the influent water until 71 to 84 per cent of each run was completed. The alkalinity of the effluent water dropped slightly below that of the influent during the last 2000 gal. of each run.

The following chemical reactions are submitted to indicate the probable action of the free CO_2:

(1) Acid treatment of raw water:

$$Ca(HCO_3)_2 + H_2SO_4 \rightarrow CaSO_4 + 2CO_2 + 2H_2O$$

and

$$H_2O + CO_2 \rightleftarrows H_2CO_3$$

Acid treated water then contains essentially:

$Ca(HCO_3)_2$ (about 30 p.p.m.)
$CaSO_4$
H_2CO_3

(2) Chemical exchange in zeolite sand after regenerating:

(a) $Na_2Ze^* + 2H_2CO_3 \rightarrow 2NaHCO_3 + H_2Ze$
(b) $Na_2Ze + CaSO_4 \rightarrow Na_2SO_4 + CaZe$
(c) $Na_2Ze + Ca(HCO_3)_2 \rightarrow 2NaHCO_3 + CaZe$

*Ze represents the electro-negative ion of the zeolite.

Reaction (a) accounts for the increase in alkalinity referred to above. To avoid this, water must be thoroughly aerated before it reaches the zeolite sand if pre-treatment with acid is adopted. If post-treatment with acid is used, the free CO_2 will be largely liberated in the deaerator, or if this equipment is not in service, it will be expelled in the steam drum.

ACKOWLEDGMENT

Alkalinity data were furnished by R. P. Watts, Panhandle Power & Light Co., Mobeetie, Texas, for which due acknowledgment is made.

*Chief Chemist, Production Department, Kansas City Power & Light Co., Kansas City, Missouri.

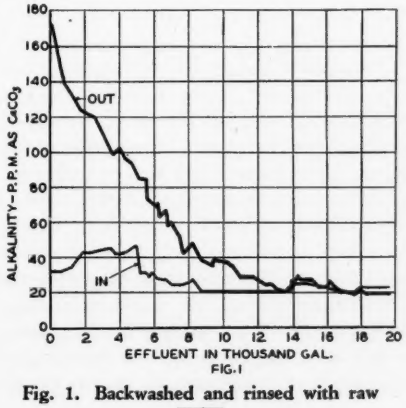


Fig. 1. Backwashed and rinsed with raw water

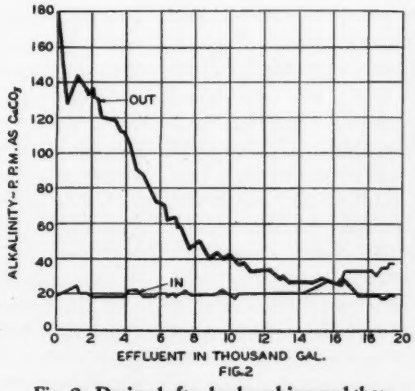


Fig. 2. Drained after backwashing and then filled with acid treated water

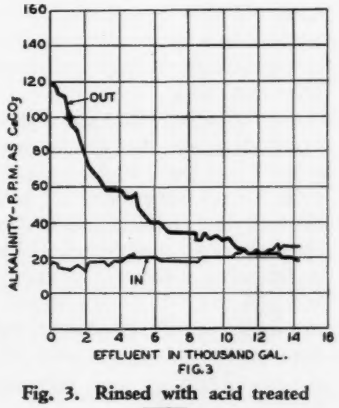


Fig. 3. Rinsed with acid treated water

Case Studies in Power Economics

Conducted By
ZUCE KOGAN
Kogan Industrial Service
Chicago, Illinois

ANNUAL SAVING OF $3600 FROM INVESTMENT OF $450

BY TAKING advantage of unused equipment and specific conditions in a given plant, many times large savings in the purchase of power may be realized.

A striking example of this type can be demonstrated by the experience we have had in a large manufacturing plant. This manufacturer's plant was subdivided into two groups of buildings, one group situated on the north side and the other group on the south side of the street. On the north side they had the public utility's switchboard, several small departments and also the office building. On the south side they had their main manufacturing establishment and they also had a power house in which they generated their own direct current electric power by means of steam. As the plant became large, however, their own generating capacity was not sufficient and two cables carrying alternating current from the main switchboard were run across underneath the street to supply light and power for the south buildings. One cable was run to the power house supplying light and power to the power house and one cable was run to another portion of the plant supplying power and light again. In other words, the south side of the plant had both a.c. and d.c., while the north side had only a.c.

In one of their store rooms they had a 100 kw. motor-generator set which was left them by former tenants in lieu of rent. This motor-generator set was of no use to them as they generated their own d.c. and they were contemplating disposing of it. There were, however, no ready buyers and thus it was lying in the warehouse occupying valuable space.

In normal times this plant was operating on a 24 hr. schedule, hence they earned a low rate from the utility on their purchased power as their load factor was quite high. When production began to taper off, however, they found that cost of power had been comparatively increased as their demand remained practically the same while the energy consumption dropped off materially.

In order to bring the power cost in line with their production and other costs we recommended that they take advantage of the utility's cheaper rate which calls for the curtailment of power use during the hours of 4:30 and 7:30 p. m. in the months of November, December, January and February. These hours are called "peak-hours" to distinguish them from the other hours which are called "off-peak-hours." The provision of the cheaper rate is that the power used during the peak-hours does not exceed 25 per cent of the maximum demand established during the off-peak period.

Upon checking the company's demand and their a.c. power and light requirements during the peak-hours, we found that while their off-peak demand was in the neighborhood of 300 kw. their peak demand was in the neighborhood of 90 kw. This consisted of lighting and electrical welding which would go on for 24 hr. a day several times during the month. While some arrangement could be made to make the company eligible for the cheaper rate, in spite of the fact that they required power during the peak-hours in the neighborhood of 30 per cent, an amount not permissible by the utility, however, this 90 kw. represented a definite charge and that portion of the power would be on the old rate and therefore full advantage of the cheaper rate could not be had. Hence, there were two problems involved. One was how to make this company eligible for the cheaper rate, and the other, how to remove this additional charge and bring the cost of power at a minimum. Naturally the simplest way out was the generation of 90 kw., a thing which is permitted by the utility without penalty during the peak-hours.

Since the manufacturer generated d.c. power and also required steam for heating, the logical thing was either to install steam generating equipment or to install a motor-alternator set so as to convert the available d.c. into a.c. for the motors and also for the lighting which, by the way, was on the power circuit. We finally decided that the best step would be to install a motor-alternator set and thus make their d.c. units assume a larger load and thus operate the d.c. generating equipment more efficiently.

It is here where their motor-generator set, for which they had no particular use, came into play. It was moved to the power house and converted into an alternator set, the d.c. generator acting as a motor which was located on the south side of the street and the synchronous motor acting as an alternator. By purchasing starting equipment in the neighborhood of $450 and changing the pulley sizes in order to obtain the right frequency, the unit was converted into a motor-alternator set, thus converting d.c. which they had available to a.c. which they needed during the hours of 4:30 to 7:30 p. m. during the four winter months.

Another difficulty arose, however, and that was the distribution of the a.c. power of the motor-alternator set. This problem was solved by taking advantage of their two cables which were used for distribution of a.c. power from the main switchboard on the north side of the street.

The output of the alternator was sent by a short cable to the power house panel. From there it was distributed in the power house and adjacent buildings and also to the main switchboard on the north side, through the cable connecting the power house panel with the main switchboard. From there it was distributed to the buildings on the north side. Also from this switchboard it was sent back to the other buildings on the south side of the street through the other cable.

In this manner the two circuits which were used from the main switchboard to supply power to the power house and to the other large buildings on the south side were utilized in a round-about way by sending power from the power house to the main switchboard on the north side and then back again to the different buildings on the south side. Thus the problem was solved as far as obtaining power and its distribution was concerned.

After making the installation they had some difficulty with their eight electric synchronous clocks. When the utility power was cut off and the motor-alternator was put into service, it was impossible to maintain absolutely correct time, on account of the speed fluctuation of the motor-generator set.

This, however, was remedied at the cost of about $8.00 per month, or $1.00 per clock per month, by renting clocks from the local telegraph company. This arrangement worked out very nicely and at the end of the year this manufacturer enjoyed a rebate of approximately $3600 realized by an investment of $450 on starting equipment and taking advantage of the peculiarities of his plant.

False Meter Readings

THE FOLLOWING CASE of "false meter readings" was brought to my attention when I was asked what could cause a meter to suddenly show a different indication. It happened that in a small plant an ammeter had been indicating for months the ampere load with its slight periodic variation due to the normal load fluctuation, when of a sudden different readings were noted. The new readings were consistently lower than the previous readings yet the plant operator was positive that the same amount of power was being delivered. The meter was checked with a standard meter and it found to register correctly.

However, the case wasn't so very peculiar after all after we looked at the circuit wiring diagram and noted that the one ammeter was used to indicate the amperes in the 3 phases of the circuit and that the current was stepped down with 500/5 amp. current transformers, one per phase. An ammeter transfer switch was used for transferring the ammeter from one circuit to another. After persistent questioning it was learned that the transfer switch sometimes stuck. Inspection showed the switch to be an old type and of poor design. Also the contacts were rough and badly pitted, the result of considerable arcing.

Having had considerable experience with current transformers and their reactions and after noting the pitting of the transfer switch I suggested that possibly an open circuit in the current transformer circuit had been the cause. The secondary circuit of the current transformer had probably been opened by dirt being forced under the transfer switch contacts. A high potential then developed between the terminals (luckily the operator did not come into contact with them and no fatality occurred) because when the secondary circuit was opened all the primary turns became effective flux producers in the core. The high flux changed the magnetic condition of the core. A subsequent ratio check showed this condition to exist.

Opening the secondary circuit of the current transformer with the primary loaded resulted in the iron loss and magnetizing current becoming abnormally high, resulting in ratio and phase angle errors being slightly greater than normal and thus resulting in false ammeter readings.

The transformer was demagnetized and restored to its normal condition by passing 150 per cent of normal (rated) current through the primary with the secondary connected to a resistance of 25 ohms. The resistance was gradually reduced to zero.

During such a test the following precaution should be taken. No contact should be made with the secondary current transformer leads or its connections as the induced voltages during the demagnetizing run are dangerous.

North Bergen, N. J. KERMIT B. HOFFMAN.

Concerning the Pulsating Load

THERE ARE many places and cases in which a belt is required to drive a machine or device upon which a pulsating or varying load is imposed. Such drive problems have often given much trouble, and continue to give trouble in many cases. Where the designer of the machine or device has been foresighted enough to incorporate a flywheel, of course enough energy is stored therein to carry the drive past the peak at each pulsation without imposing so much strain upon the belt.

Where the belt is afforded no such relief as that represented by a flywheel or any similar device, the sudden slowing-up effect is of course transmitted directly to the belt, and this results in the belt stretching considerably on the tight side of the drive at the moment or instant the peak load is imposed. This continual stretching and taking-up of stretch which occurs alternately will cause a long belt to flap severely, and a short belt will slip at once when the stretch occurs. At any rate, this is what happens when the belt is simply running upon two pulleys with immovable centers, and no especial provision made for taking up the stretch as it occurs.

The use of a wrapper pulley alleviates such a condition very much, because such a pulley will take up the stretch at once if it is working properly. Aside from the wrapper pulley, or idle tightener, as some are pleased to call it, the only other means I know for taking up the stretch automatically as it occurs is in the case of a motor drive, where the motor is mounted on a pivot-type base, in such manner that the dead weight of the motor, acting by gravity, tends to keep the belt tight. In such a layout, it is a sure thing that enough slackness cannot result from belt stretch at peak load to cause excessive slipping, even where the driving belt is quite short.

Peoria, Ill. JOHN E. HYLER.

Atlantic City *welcomes* Third Convention *of the* E.E.I.

Politics Play an Important Part in Convention as the Utility Industry Prepares for War of Self-Preservation. Thomas N. McCarter Continues as President of the Edison Electric Institute

REFLECTING the hostile attitude of the Administration toward the utilities, politics and political policies played an important part in the Third Annual Convention of the Edison Electric Institute, even the strictly engineering and sales papers being colored by frequent references to the difficulties besetting the industry on all sides. Naturally the Federal Trade Commission, the Federal Power Commission and the pending Wheeler-Rayburn Bill bore the brunt of the attack although other Federal agencies, notably the P.W.A. and T.V.A. did not escape unscathed.

In reviewing the eight years' investigation of the industry of the Federal Trade Commission, Bernard F. Weadock, counsel of the Institute, charged that it "was predestined to be a propaganda vehicle to further the whims and fancies of those who would destroy the American system of private business for private property" and asserted that the investigation was conducted by and the report prepared by subordinates without knowledge and training in the utility business; that the investigation was conducted in an arbitrary manner without following established legal procedure; that the industry was not allowed to present its case properly; that a few companies whose practices were condemned by the industry itself were held up as typical and that news releases were conflicting and drawn in accordance with the direction of the political weather cock at the time, and in conclusion said, "I am unable to find more suitable words than these—fraud, deceit, misrepresentation, dishonesty, breach of trust and oppression—in characterizing the investigation by, and findings of, the Federal Trade Commission."

The attack was continued by Frank W. McLaughton of the Puget Sound Power & Light Co., who placed the government in the triple role of "oppressor, competitor and executioner" as the opponent in the greatest battle the industry has ever faced. Building good will by placing the facts before the public and relying on its sense of justice and fair play was offered as a solution and warmly seconded by J. F. Owens of the Oklahoma Gas & Electric Co., who further recommended that the Institute proceed with plans for checking material printed in national periodicals. This plan has been followed successfully with local publications and it has been his experience that periodicals are fundamentally honest and, even though unfriendly, will not continue to publish material that is proved to be in error. Even paid advertisements are sometimes advisable to bring the truth home to the public and combat unfair propaganda.

Electric Utility Industry Ranks Fourth in Nation

In his presidential address Thomas N. McCarter of the Public Service Electric & Gas Co., summarized the progress of the industry, from scratch fifty years ago to the fourth industry of the nation today, and enumerated the major Administration attacks including: the three per cent Federal tax; the Johnson Bill denying the use of the Federal Courts in certain rate cases; the power rate investigation of the Federal Power Commission; the T.V.A. and other uneconomic power developments; the P.W.A. grants for the building of municipal plants; the rebuffs offered the industry on suggested internal reforms; the Wheeler-Rayburn Bill and court action on various litigations which promises some measure of relief by declaring unconstitutional some of the measures. He concluded with the restrained statement, "I will not bring myself to speak in any terms of disrespect of the President of the United States, but I do not think I go too far when I say that he seems to have an obsession on this subject. If I may say so without offense, I think the big mistake of his Administration is trying to combine too much reform, that needs to be carefully digested before enactment, with recovery, the need for which is instant."*

Trend Toward Federal Control

Less restrained was Merle Thorpe, editor of "Nation's Business," who declined an invitation to speak on what is going on in Washington but did accept the invitation to describe what is going on. The present trend toward stronger Federal control, he said, is not new nor is it confined to this country. It is but part of a world wide movement expressed in Europe by Communism, Hitlerism and Fascism, movements frowned upon by Americans when called by names associated with violence but taken willingly by them in sugar coated doses under less objectionable names and peaceful circumstances.

*A resolution adopted at the convention recommended that the present hour and wage scale be continued in spite of the recent decision of the Supreme Court declaring the N.R.A. unconstitutional.

Taking the ten points laid down by Marx almost 100 yr. ago, he analyzed several of them and pointed out how closely they are paralleled by present or contemplated legislation. These include: centralization of credit in the hands of the state; control and operation of communications and transportation; combination of agriculture and manufacturing industries; extension of factories and instruments of production and cultivation of waste lands in accordance with a common plan; equal liability of all to labor; a heavy progressive or graduated income tax; abolition of the rights of inheritance; abolition of property and land and application of all rents of land to public purposes.

Promotion of Power Projects

One of the most important phases of this proposed administration program, as far as the utilities are concerned, is the activities of the P.W.A. in promoting power projects which are in direct competition with private utilities. This activity, which covers both Federal and non-Federal development, has taken the form of loans and grants, the former at very low rates of interest, the latter amounting to 30 per cent of the cost of labor and material on the present grants and a reported 45 per cent on the projects now under consideration.

This activity was covered thoroughly by H. W. Fuller of the Byllesby Eng. & Mgt. Corp., in his paper, "Subsidized Electric Plants." His paper, strikingly and dramatically illustrated by immense charts and maps, traced the tide of municipal plant P.W.A. allotments from an early peak of 335 in February 1934 to a total of 99 in April 1935, the decrease being due largely to unwillingness of municipal authorities to accept the terms of the P.W.A.; adverse results of elections; and opposition of private utilities affected.

In addition to strictly city and county projects two other non-Federal projects, the Loup River and Sutherland developments in Nebraska, came under fire as serving no real need and being made economically possible only by the large subsidy reserved. In the same category were placed several Federal projects, Boulder Dam, Tennessee River, Columbia River, Bonneville and Grand Coulee, Caspar-Alcova, Fort Peck and Passamaquoddy, a recently added tidal development in Maine.

Mr. Fuller analyzed the actual and potential power consumption in the territories which would be served from these projects and showed the economic absurdity of the developments. Referring to recent court decisions, primarily in connection with non-Federal works, Mr. Fuller said, "We have good ground for hoping that this high handed method of attacking our business will be prohibited by the Supreme Court."

Specific reference to one of these Federal developments, the so-called "yardstick" of the government, was made by Ezra B. Whitman, a consulting engineer of Baltimore, who has been retained by the Alabama Power Co. in connection with their suits against the T.V.A. Major Whitman analyzed rate making by the T.V.A., criticized their interest and tax allowances, rate base, consistency of figures presented in different court cases, and the validity of these figures when used for rate making purposes. The only comparable development, that of Ontario, Canada, has retired only 7 per cent of its capital investment in 30 yr. operation and had a deficit in 1933, according to Mr. Whitman who continued with the question, "Can the T.V.A. with their much lower rates . . . succeed in wiping out a $60,000,000 debt?"

System Interconnection

Another activity of the government, the report of the National Power Survey, threatening a shortage of power, was refuted by Marion Penn of the Public Service Electric & Gas Co. In a strictly engineering analysis entitled, "Plant Modernization," Capt. Penn showed how system interconnection has made it possible to take advantage of the diversity factor among systems so as to enable each to reduce its standby equipment and in some cases carry a peak load practically equal to name plate ratings. Furthermore so-called obsolete equipment is performing its present function of carrying peak loads in an economical manner.

Present capacity may be quickly added, the most promising method at present being by superimposing steam or mercury equipment on present units. Taking his own system as an example, Capt. Penn showed how the present capacity could be practically doubled by this method. Nor could war cause any shortage. The U. S. A. has more than the combined capacity of Great Britain, France and Germany, and working three shifts a day would double the power available with present capacity. Discussion from various sections of the country by A. D. Bailey of the Commonwealth Edison Co., A. H. Kehoe of The New York Edison Co., J. M. Drabelle of the Iowa Electric Light & Power Co., and F. S. Clark of Stone & Webster Eng. Corp. confirmed Capt. Penn's analysis and conclusions and showed that the utility companies are fully alive to the situation and have already made plans to take care of increased load, when the capacity is needed, without loss of time.

Plant costs and reports prepared by various government bodies, purporting to show that facilities for power supply could be built much more cheaply than the cost of existing power systems are the ideas of men who never had the responsibility of building or operating such systems according to N. E. Funk of the Philadelphia Elec. Co. In his paper, "The Effect of Service Standards on Electric System Design" he placed continuity of service first in the list of major factors of acceptable service and showed how this together with voltage regulation, safety and customer contact influenced the design of the entire system. H. R. Woodrow of the Brooklyn Edison Co., and W. E. Mitchell of the Georgia Power Co., discussed this paper with particular reference to their own system standards and the promotion of satisfaction among domestic and industrial customers.

Use of Domestic Electricity Stimulated

Government activity has, however, stimulated the sale and use of domestic electricity and has thus been of some indirect benefit to the utilities although the rural electrification intentions of the Administration were questioned by Hudson W. Reed of The United Gas Improvement Co., who said, "To the professional friend of the farmer it is a political expedient by means of which he hopes to be remembered by his rural con-

stituents. . . . Note that this clamor has not been initiated by the farmer himself. Only in the imagination of those, his champions, does there exist any widespread demand for electric service on the farm, or any general willingness, or ability, to pay for it."

Wheeler-Rayburn Bill Considered Menace

The last session of the Convention was an open forum on the Wheeler-Rayburn Bill at which George M. Gadsby of the Utah Power & Light Co., and J. G. Holtzclaw of the Virginia Electric & Power Co., presented papers, and T. Justin Moore, a lawyer of Richmond, Virginia, answered questions from the Question Box. The purpose of the forum was to impress upon the operating companies the direct menace to them in Title II of the bill as well as to emphasize to the holding companies their threatened extinction as embodied in Title I. The discussion left little doubt in the minds of the audience that the bill as it now stands puts a hangman's noose about the neck of the entire industry, for as Mr. Gadsby pointed out, the industry must look at the bill as it reads and not at the latitude allowed the enforcing commission, for sooner or later the commission empowered to act will proceed in the direction intended by the framers.

So-called past abuses in the industry were characterized as a smoke screen to hide the true nationalization interest of the measure which was said to be backed by government employees thirsty for power and would not be abided by the American people and American courts. Operating companies which have not been criticized are said to be subjected to the same drastic treatment as the holding company and the objectionable common carrier clause, although eliminated, still remains in such a form in other sections as to compel these companies to take the output of the Federal projects such as Bonneville, T.V.A. and Grand Coulee.

As a fitting close to the convention George B. Cortelyou, the first and only past and ex-president of the E.E.I., made an impromptu speech emphasizing that associations like individuals, have character and that the institute must expend its energy in carrying the truth about the industry to the public. Progress is made not by genius but by the common effort and by the sinking of minor differences the industry will overcome the present embarrassments.

Prizes Awarded

Prize awards were presented by Frank W. Smith of The New York Edison Co. as follows: The Charles A. Coffin award for distinguished contribution to the industry for the convenience of the public and benefit of the industry to the Tennessee Electric Power Co.; the George A. Hughes award for the development of domestic electric cookery load to the Florida Power & Light Co.; the Thomas W. Martin award for advancement of rural electrification to the Puget Sound Power & Light Co.; the H. M. Byllesby prizes for accounting, first prize to R. E. Kerns of the Oklahoma Gas & Electric Co., second prize to John H. O'Grady of the Chicago District Generating Corp., third prize by Samuel J. Helfman of the Philadelphia Co.; the B. C. Forbes prize for public relations to Robert C. Cleminson of the Nebraska Power Co., and due to the closeness of the decision, Honorable Mention to Eugene R. Schief of the Brooklyn Edison Co., Daniel Ravenel, Jr., of the South Carolina Power Co. and William E. Frazer of the San Diego Consolidated Gas & Electric Co.; the A. L. Lindermann prizes for electric cookery, first prize to Mrs. Dera Arrington of the Oklahoma Gas & Electric Co., second and third prizes to Miss E. Mae Jones and Miss Anne L. Robertson, respectively, both of the Virginia Electric & Power Co.; the James H. McGraw prizes for engineering, first prize to J. E. Allen and G. J. Gross of the Pennsylvania Water & Power Co., second prize to George G. Guthrie of the Detroit Edison Co., third prize to Mr. L. Waring of The New York Edison Co.

Announcement was also made of the re-establishment during the ensuing year of the Curtis award for commercial lighting, and 12 E.E.I. life saving medals were awarded to the following: Arthur Faires, Pennsylvania Power & Light Co.; Lafayette G. Nelson, Elk River Power & Light Co.; John J. Christopher, New England Power, Eng. & Service Corp. (with a certificate to Chas. Malaguti who assisted him); Mortimer G. Williams, Marlborough Electric Co.; Nahen Jabbour, Fall River Electric Light Co.; The Line Gang, of the Tide Water Power Co., consisting of Caleb B. Bartling, J. W. Quick, A. L. Brown, Duncan Davis and Thomas Hailey; Gerald Roberts, Green Mountain Power Corp.; H. W. Slagle, Pennsylvania Power Co. (certificate to Thomas Clyde who assisted); Harry A. Glover, Duquesne Light Co.; Edward O'Mara, Philadelphia Electric Co.; Howard S. Leech, Virginia Public Service Co.; Leslie G. Shelton, Texas Elec. Service Co.

Officers elected for the ensuing year are: President, Thomas N. McCarter of the Public Service Electric & Gas Co.; vice-presidents, Paul M. Downing of the Pacific Gas & Elec. Co., A. H. Kehoe of The New York Edison Co., J. G. Holtzclaw of the Virginia Elec. & Power Co., James E. Davidson of the Nebraska Power Co.; vice-president and managing director, H. S. Bennion; treasurer, Edward Reynolds, Jr.; secretary, Mae B. Woods. The Board of Trustees elected include: Frank D. Comerford of The Edison Electric Illuminating Co.; Samuel Ferguson of the Hartford Elec. Light Co.; C. E. Groesbeck of the Electric Bond & Share Co.; Wm. J. Hagenah of the Northern States Power Co.; George O. Milford of Stone & Webster, Inc.; Alfred H. Schoellkopf of the Niagara-Hudson Power Corp.; P. H. Gadsen of the United Gas Improvement Co.; E. W. Wakelee of the Public Service Elec. & Gas Co. The changes from last year consist of the election of Mr. Davidson as vice-president, the transfer of Mr. Hagenah from vice-president to Trustee and the election of Messrs. Schoellkopf, Gadsen and Wakelee to the Board of Trustees.

How to separate monel metal from steel rivets when thousands of them are mixed together in a heap, is the problem which confronted a manufacturer recently. Ordinarily, he probably could have had the pile watered, and then picked the monel rivets from the rusty steel by hand; but the size of the job made such procedure impractical. Making use of the peculiar property of monel metal, that it loses its magnetic qualities at about 200 deg. F., he heated the rivets and easily accomplished the separation with a magnet.

National District Heating Association *meets at* Philadelphia

Twenty-Sixth Annual Convention held June 11 to 14 looks forward to greater accomplishments

ON HIS FIRST ADDRESS as president, R. L. Fitzgerald of the Duluth Steam Corp., newly elected president of the association, emphasized the note of optimism current throughout the convention and felt that the turning point had been reached and the industry would now go forward to greater things.

For the first time in several years the association has managed to clear up the deficit from the beginning of the depression and is back on a cash basis so that next year preprinting of the papers and committee reports will probably be resumed so as to allow members to take advantage of the operating suggestions four to five months before the proceedings are published. Committee chairmen were cautioned to have their reports ready 60 to 90 days before the next convention date so that the editing committee could arrange for the preprints.

As usual the convention was concerned primarily with operating problems, with sales and public relations with customers forming important but minor themes. One session dealt entirely with hot water heating, another largely with distribution problems and a third with cinder and dust elimination; in all three the problem of metering and instrument control played an important part.

The papers were too numerous to list here and many will be abstracted in later issues. Papers of primary interest to the power plant field were New Developments in Temperature Control by Albert Fry of the Illinois Maintenance Co.; Operating Economies Reached by Control of Steam Jet Refrigeration by A. R. Mumford and Ralph Menkes of the New York Steam Corp.; Steam Consumption in College Buildings by R. Y. Sigworth, Pennsylvania State College; The Present and Future Status of Hot Water Heating by A. Margolis of Hamburg, Germany; and Zeolites by L. F. Collins of the Detroit Edison Co., a critical review of the past and present work of his company with water treatment by means of zeolite, sulphuric and phosphoric acid.

The session on cinder and dust elimination was unusually complete. John Dallas of the Philadelphia Electric Co. outlined the experience of his company along this line since 1921; N. S. Wade of the Edison Electric Illuminating Co. told of his company's experience with the Pease Anthony gas scrubber, and F. P. Fairchild of the United Engineers & Constructors, Inc., described the installation made for the new Triangle heating plant in Washington, D. C., a combination cinder catcher and electrostatic precipitator of a new design which has given satisfactory service in a district where cinders and dust cannot be tolerated.

In addition to R. L. Fitzgerald, the new president, other officers elected included: M. D. Engle of the Edison Electric Illuminating Co., first vice-president; T. E. Purcell of The Allegheny County Steam Heating Co., second vice-president; J. R. McCausland, Jr., of the Philadelphia Electric Co.; and for the Executive Committee, Wm. J. Baldwin, Jr., of the New York Steam Corp., G. D. Winans of The Detroit Edison Co., and Edw. Lenz of the New York Steam Corp.

In addition to the convention there was a small but excellently arranged exhibition where the following manufacturers displayed their latest products: H. Belfield Co., American District Steam Co., Ric-wiL Co., E. B. Badger & Sons Co., Taylor Instrument Cos., National Tube Co., Schade Valve Mfg. Co., General Electric Co., American Radiator Sales Co., Schutte & Koerting Co., Jas. P. Marsh Corp., Foster Engineering Co., The Foxboro Co., Central Station Steam Co., Spence Engineering Co., Midwest Piping & Supply Co., The Bristol Co., Minneapolis-Honeywell Regulator Co. and The Brown Instrument Co., Yarnall-Waring Co., Keasbey & Mattison Co., Bailey Meter Co., Warren Webster & Co., Philadelphia Electric Co.

Accident Rates Among Utilities

IN FIGURES just made public by the National Safety Council, it is revealed that the accident rates in the public utilities industries during 1934 showed an increase in frequency of 13 per cent over 1933 and in severity the increase was 8 per cent. Industry as a whole showed an increase of 5 per cent.

These rates are based upon reports from 612 utility companies, whose employes worked 651,273,000 man-hours. The frequency rate is based on the number of disabling injuries per million man-hours of work, while the injury rate is determined by the number of days lost through injury per one thousand hours of exposure.

Although showing an increase, the utilities industries averaged 10.54 for frequency last year as compared to 15.29 for industry as a whole, while corresponding severity rates 1.68 and 1.70 respectively. Thus in the Council's list of 30 major industries, utilities ranked eleventh on the basis of frequency and seventeenth on that of severity. Since 1926, the frequency of disabling injuries has decreased in this industry 78 per cent in comparison with 57 per cent for industry as a whole; in severity this decrease has been 66 per cent as compared with 37 per cent for all industries.

Among the electric utilities, the Nebraska Power Co. had the lowest frequency rate (0.76) among large units, while the Public Service Co. of Oklahoma had the lowest severity rate—0.02. To the Green Mountain Power Corp., Electric Division, goes the record, among middle-sized units, of working the most hours (349,000) without a disabling injury—a perfect 1934 record. The Panhandle Power and Light Co., among the small units, also achieved a perfect record without a disabling record with 260,000 hours of work, while the Quincy Electric Light and Power Co. was the largest small unit to achieve a perfect 1934 record and thereby reduce both injury rates 100 per cent since 1932.

Readers' Conference

Bearing Clearances Require Precision Measurement

SOME 40 YR. ago, when I was an apprentice, it was a standby rule that keys and wedges be driven home, then backed off a certain number of sixty-fourths or squares. No one ever volunteered to tell why, whether it was scientific deduction, rule of thumb or just plain guess work.

Then, while still a youngster, I worked for an engineer who was forever talking in thousandths. After listening to his enigmatic ramblings for some time, I demanded to know just what the thousandth of an inch really was, and he answered: "I'll tell you and you'll never forget. If you had a hole just exactly one inch in diameter, and you tried to enter a pin that was one thousandth of an inch larger, it wouldn't go. That is the answer to what is a thousandth of an inch."

He was right in one respect. I never forgot, but I learned something that he evidently didn't know. I learned that a pin, just exactly one inch in diameter, wouldn't go in a hole *just one inch in diameter.*

There was a reason why the keys and wedges should be backed a certain amount. To operate properly a certain clearance had to be established.

When a box is properly lined with anti-friction metal, and carefully machined, it takes no expert with several sets of scraping tools, to make it fit. When I say properly machined, I mean bored on a true faceplate or boring mill.

A crank or wrist pin, to make a true contact, can bear in the box no more than the diameter of the pin; that is, a 10-in. pin can have, in each half box, only a contact of 10 in. measured along the arc of contact.

If the pin is round and of the same diameter at all points, 0.0005 in. clearance, to every inch diameter of the pin, should insure perfect operation. This will also hold good, regarding journal bearings, if 0.001 in. is allowed.

Three styles of take-ups are shown here. The common strap, key and gib; the wedge and the marine end. In each case, a 10-in. pin is taken.

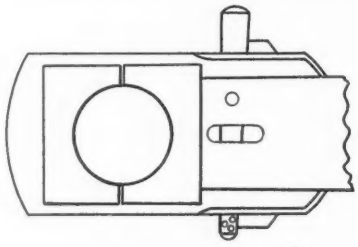


FIG. 1
10-IN. PIN
KEY = 22 1/2 IN. LONG
TAPER = 3 − 1 5/8 = 1 3/8 IN.
$\frac{1\ 3/8}{22\ 1/2}$ = 0.0611 PER INCH
$\frac{0.006}{0.0611}$ = 0.0982 OR APPROX. $\frac{6.2}{64}$ IN.
ALLOWING FOR 0.006 IN. CLEARANCE

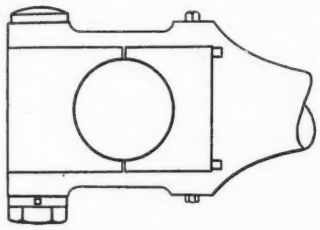


FIG. 2
10-IN. PIN, WEDGE 8 IN. LONG
TAPER = 2 15/16 − 1 3/4 = 1 3/16 IN.
OR $\frac{1\ 3/16}{8}$ = 0.148 IN. PER IN. OF LENGTH
WEDGE MOVEMENT FOR 0.006 IN. BEARING CLEARANCE = $\frac{0.006}{0.148}$ = 0.040 IN.
DRAW BOLTS = 1 IN. DIAM.; PITCH, 8 PER IN.
ONE TURN OF DRAW BOLT = 1/8 OR 0.125 IN.
$\frac{0.040}{0.125}$ = 8/25 OR PRACTICALLY 1/3 TURN

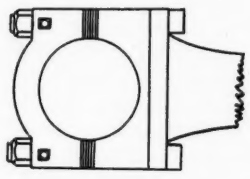


FIG. 3
10-IN. PIN

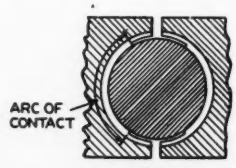


FIG. 4

Fig. 1. Strap key and gib type crank pin bearing
Fig. 2. Wedge type bearing
Fig. 3. Marine type bearing
Fig. 4. In good practice the arc of contact is equal to the diameter

With a 22½-in. key, width reduced from 3 in. to 1⅝ in., giving a taper of 1⅜ in., (Fig. 1), a set back of the key of approximately 6/64 in. should ease the box 0.006 in.

In the wedge type (Fig. 2), the 8 in. wedge tapers from 2 15/16 to 1¾ in., making 0.148 in. to the inch of length. The draw bolts have eight threads to the inch, so that backing off two squares or 1/3 of a turn, gives approximately 0.006 in. clearance. Allowing 0.006 clearance on the marine end should provide a perfect job.

This bearing may be adjusted by trial leads, either placed directly on the circle of the pin or between the halves. If liners or shims are left out to the approximate amount of 1/16 in., then lead fuse wire is carefully laid in the cap circumferentially, and the cap pulled up snugly, a micrometer measurement of the wire plus 0.006 for a 10-in. pin, will allow sufficient clearance. If liners, as above, are left out and the wire

placed crosswise in the liner space, the cap pulled carefully to place, the same results will obtain.

An instance of thousandths of an inch, and what it means on a bearing was exemplified several years ago by the breaking of a small turbine spindle, at the outboard bearing.

This turbine operated at 30,000 r.p.m. and the outboard bearing was approximately 5/16 in. in diameter. It developed about 5 hp. and operated as smoothly as any machine possibly could.

After about 9000 hr., the spindle snapped off at the point where the diameter changed from hub to bearing size.

It was necessary to replace the whole spindle which included herring-bone gears. As the bearing was of the solid type, I had a set of plug gages made to fit the new bearing and also to fit the old bearing.

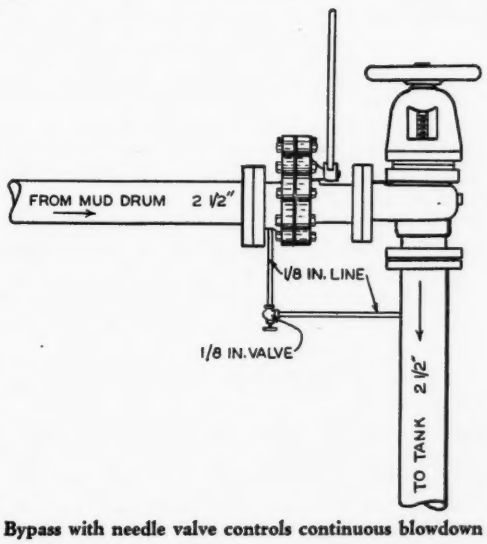
The new bearing cleared the spindle by 0.0015 in.; the old one cleared by 0.003 in. The difference of 0.0015 in. allowed the spindle to vibrate and it crystallized.

The cost of a bearing was not prohibitive so I installed a new bearing every 7000 hr. Our machine shop renewed the soft metal and reamed and rifled it for oil ways. With 7000 hr. operation, the bearing showed 0.001 in. wear.

Boston, Mass. TOM THUMB.

Simple Continuous Blowdown

OPERATING at high rating with 100 per cent make-up water, containing quantities of scale forming matter, which is very detrimental to equipment, it was found necessary to use a compound to keep concentration where it should be, and at all times to know alkalinity, chloride content and hardness of boiler water.



Bypass with needle valve controls continuous blowdown

It was also necessary to blow down boilers at regular intervals, nine times per 24 hr. through a 2½-in. blowdown line. This frequent operation of valves under 250 lb. pressure caused excessive wear and additional maintenance cost on valves.

With this additional service and cost, and still trying for better service the following idea was worked out. A ⅛-in. line bypassed both 2½-in. valves as shown in sketch, the discharge being controlled by means of a ⅛-in. angle needle pointed valve.

I have found that operating at normal boiler horsepower, this ⅛-in. valve will take care of blowdown very nicely at 250 and 300 per cent ratings. It is necessary to open 2½-in. valves for one-half minute for each 8 hr. run. I have also found it possible for long periods to maintain a uniform maximum concentration, and in this way considerable saving is obtained by keeping blowdown at a minimum at all times.

This bypass has been in use for over a year. Some form of heat exchanger should be installed to reclaim the heat from the blowdown water.

Somerville, Mass. WILLIAM A. LACEY.

Suggestions from Employes

THE ARTICLE by Mark Bell, entitled "When I Buy My Power Equipment" published in your April issue, contains some valuable suggestions, which I presume are made from the point of view of the manufacturer rather than the power plant engineer.

Many of the largest manufacturing concerns in the country have installed suggestion systems with more or less satisfactory results; their value, however, would appear to depend almost entirely upon the intelligent coöperation of the management, but it has been pretty definitely proved that these systems will not run themselves and, if they are not properly controlled, they may easily do more harm than good. Undoubtedly the principle is correct but it is not so easy to apply it in a satisfactory manner.

In the case of large organizations which can permanently employ a plant engineer of professional rating, the responsibility for the efficiency of the plant should rest with him and, if he is fitted for his job, he should receive the whole hearted coöperation and support of the management.

He may think it advisable to encourage suggestions from those under him but the policy of encouraging assistants to make suggestions "over his head" is a very doubtful one, in fact, it should not be considered for a moment unless a plan which will not undermine his authority can be worked out with his full coöperation.

No doubt Mr. Bell has chiefly in mind small organizations which employ men only of the grade of operating engineers and firemen, master mechanics and maintenance men, in which case suggestions and recommendations from the men who are to handle the equipment may prove to be of great value, but they should be passed upon by someone who is fully qualified to judge their merits.

If there is no one among the higher officials who is a qualified engineer, I would suggest the advisability of retaining the services of an independent consultant to review the suggestions made by the employes.

Under the supervision of a thoroughly qualified man, a suggestion system might be installed at a small cost, and awards might sometimes be made for suggestions which indicated an intelligent interest in the operation of the plant, even when they could not be followed.

The case used as an illustration by Mr. Bell clearly

indicates the necessity for the services of a thoroughly qualified engineer.

The two proved facts appear to be:

1. There is a large number of units involved.
2. The gate valves as now installed for controlling the discharge of the material are not satisfactory.

Now, it is possible that the suggestion made by Mr. Bell, that globe valves should be used, may provide the correct solution, and if he has actually used globe valves with identical material, no doubt it is; but if he has not had actual experience, would it not be better to have a qualified engineer make an investigation?

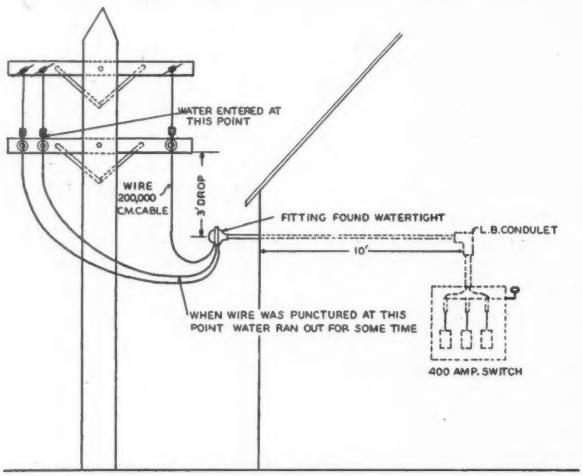
One globe valve might be tried as an experiment, and perhaps further investigation would indicate that a special valve might be designed which would give satisfactory results. In any event, the operation would appear to be of sufficient magnitude to warrant the expenditure of a reasonable amount of money, and the right way to go about it is to get a well qualified and experienced man to supervise the job.

Almost all suggestions made in good faith are worthy of some consideration, but it takes a well qualified man to pass upon their merits. A small part of the money wasted each year through acting upon ill considered suggestions would keep a number of competent professional engineers usefully employed.

Bloomfield, N. J. JAMES O. G. GIBBONS.

Water Flows Through Electric Conductor!

THE ACCOMPANYING drawing shows how water entered a motor switch in one of our Pump Houses. The cover was removed from the L. B. Condulet and all the


WATER ENTERED AT THIS POINT
WIRE 200,000 C.M. CABLE
3' DROP
FITTING FOUND WATERTIGHT
L.B. CONDULET
10'
WHEN WIRE WAS PUNCTURED AT THIS POINT WATER RAN OUT FOR SOME TIME
400 AMP. SWITCH

wires and inside of fitting were found dry. Next the entrance fitting was inspected and likewise found watertight.

We then inspected wires on the lower crossarm and there found on the middle wire a poorly taped joint. This was allowing water to leak in between the insulation and the copper strands and flow the entire length through the wire down into the switch. Upon puncturing the insulation at the drip loop, water ran out of the wire for some time. After the joint was retaped and painted, no more trouble was experienced.

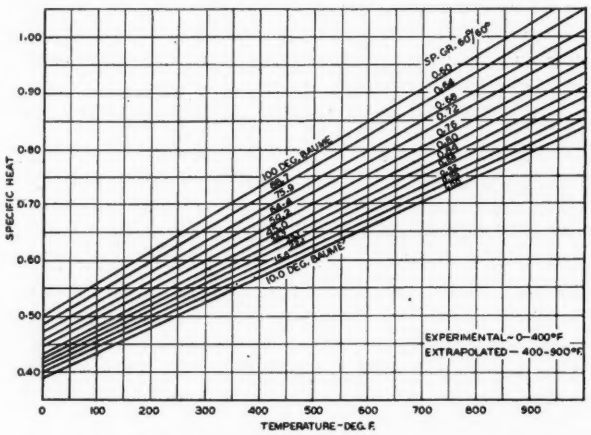
Richmond, Va. E. C. MURRAY.

As One Engineer to Another

NOTWITHSTANDING the elementary nature of the problems discussed by G. E. Wetzel in the May issue, pp. 302-304, the author is not sufficiently exact for practical purposes in his definition of specific heat in general, and particularly with reference to fuel oil. He also gives figures for specific gravity and heat value of fuel oil which may be misleading.

Mr. Wetzel's definition of specific heat, although partially correct, needs qualification. He said: "Specific heat is the amount of heat, expressed in B.t.u. required to raise the temperature of one pound of solid, liquid, or gas, one degree Fahrenheit."

From this, one would think that specific heat always is expressed in B.t.u. He should have said: "Specific heat, when expressed in B.t.u., is the amount of heat, etc." This wording is necessary, because specific heat may be expressed in calories as well as British thermal units. Furthermore, Mr. Wetzel should have modified the term "specific heat" by the adjective "instantaneous" and further qualified the definition by stating that this addition of heat must be at some definite temperature. It is not sufficient to say



Curves show values of instantaneous specific heat per lb. for various densities of petroleum oils from zero to 900 deg. F. Plotted from Table 12, Misc. Pub. No. 97 Bureau of Standards (1929)

that the heat added is to raise the temperature of a substance one degree, but it should be pointed out that the amount of heat required varies with the temperature range. Raising the temperature of one pound of oil from, say, 100 to 101 deg. F., requires less heat than to raise one pound of this same oil from say, 600 to 601 deg. F., although there is one degree rise in both cases.

Specific heat of most substances increases constantly as the temperature increases so that in calculating heating problems such as Mr. Wetzel propounded to the Chief, it is necessary to consider "mean" specific heat.

Mean specific heat of a substance, over a given temperature range, is the value by which such range must be multiplied to determine the amount of heat required to raise unit weight of the substance through this range, under given conditions of pressure or volume.

Mr. Wetzel says every substance other than water has a specific heat less than one B.t.u. Hydrogen has a mean specific heat of 3.385 B.t.u. in the range from

0-60 deg. F. and for helium it is about 1.25 B.t.u. At higher temperatures, these values increase.

In referring to the heating problem, it should be pointed out that the term "fuel oil" should be defined within limits. Oil refineries generally refer to the density of oils in terms of degrees Baumé (A.P.I. Standard) instead of specific gravity. The density of fuel oil varies over a wide range, but the commercial grade as sold to power plants has a density of 14 to 26 deg. Bé., which expressed in specific gravity is 0.9725 to 0.8975.

Commercial grades of fuel oil seldom have a specific gravity lower than 0.875 (30 deg. Bé.). The assumed "fuel oil" in Mr. Wetzel's problem which has a specific gravity of 0.8 (45 deg. Bé.) is not fuel oil, but a light grade of kerosene.

Assuming, however, that the oil under discussion actually did have the density as given, Mr. Wetzel is in error in assuming that the value for specific heat is 0.55 B.t.u. per pound. In the first place, apparently he did not calculate mean specific heat over the range of temperature from 50 to 100 deg., but assumed that 0.55 B.t.u. was added for each degree from 50 to 100 deg. Secondly, 0.55 is too high for kerosene or even gasoline within the temperature range given.

From time to time, various empirical formulas have been offered by engineers for the calculation of instantaneous specific heat for petroleum oils but they generally agree within 0.015 B.t.u., for oil of the same density within the range of 50 deg. to 100 deg. F.

The accompanying curves give specific heat values (instantaneous) for various densities of petroleum oils from 0-900 deg. F.

The specific heat for oil with specific gravity 0.8 at 50 deg. is 0.456 and at 100 deg. it is 0.481. The arithmetic mean of these values is 0.4685 which is the value which should have been used in Mr. Wetzel's equations. The answer then, would be approximately 1300 lb. steam instead of 1527 lb. This is a decrease in steam consumption of 13 per cent. If the temperature range had been greater, the error would also have been greater.

In figuring the fuel oil required to heat the oil, Mr. Wetzel assumes a calorific value of 148,000 B.t.u. per gal., which is much too high for the oil which he assumes has a specific gracity of 0.8. Kerosene of this density will average 19,500 to 20,000 B.t.u. per lb., and with 6.67 lb. per gal., the total heat per gal. will be 130,000 to 133,500 B.t.u.

Even regular fuel oil of 24 deg. Bé. (0.91 Spec. Grav.), seldom exceeds 18,750 B.t.u. per lb., so that the total B.t.u. per gal., is approximately 142,000. To obtain 148,000 B.t.u. per gal., we would have to use an oil weighing about 8 lb. per gal. (0.96 Spec. Grav.), with a heat value of about 18,500 B.t.u. per lb. It is, of course, entirely possible to have such oil, but it is not in accordance with conditions previously given unless the fuel oil used to generate the steam is entirely different from the so-called fuel oil being heated in the tank car.

J. R. DARNELL.

Chicago, Ill.

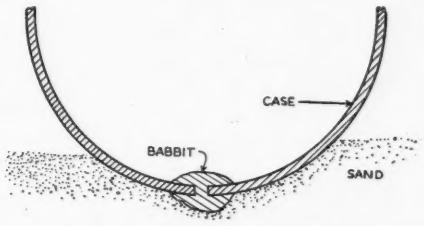
"WHEN THE Government once enters a business it must occupy the field alone. No one can compete with it. The result is a paralyzing monopoly."

CALVIN COOLIDGE.

Babbit Repair Kink

THIS SKETCH shows a method I have successfully used for closing holes in castings such as oil reservoirs, crank cases, etc., by means of babbit metal. It is quicker than any other method I have encountered.

Simply place the broken part in a box of sand, as illustrated. Push away enough of the sand from the edge of the hole so that the babbit will securely clamp



Method of repairing leak with babbit

around both sides. You are then ready for the pouring of the babbit.

Welding, of course, is better, but for temporary work this babbit method serves the purpose very well. In fact, one of my babbit repair jobs performed more than 20 yr. ago is still good.

If you have no babbit, use lead or similar metal having a low melting point.

Newark, N. J. W. F. SCHAPHORST.

Problem in Areas

DURING the past several years, it has been my fortune or otherwise, to be blessed with three steam engines that had their cylinders bushed.

The first case (illustrated) was a high pressure engine with 26-in. cylinder, operating condensing. As it was desired to compound this unit, the 26-in. cylinder was bushed to 20 in. and a 40-in. low pressure cylinder was added. The unit was thus turned into a tandem-compound with the high pressure cylinder forward.

During the preliminary talk, a mechanic figured the area of the end of the bushing, thus: $23 \times 3.1416 \times 3 = 216.77$, and 216.77×150 (pounds steam pressure) $= 32{,}515.5$ or 16 tons plus.

Right off, the mechanic also figured that he should put in sufficient screws to withstand a 16-ton shearing strain, but his foreman laughed and told him to forget it.

Said the foreman, "If we make a bushing that absolutely fits, it not only will push in properly but it will be of just the right length to butt the forward cylinder head, and, in turn, be butted by the rear cylinder head."

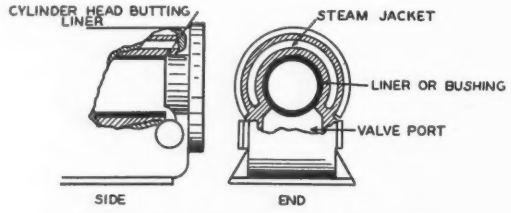
In the sketch, just one quarter of the area of the bushing is exposed to pressure, and the bushing can't go anywhere as it butts the forward head, also the rear head.

Another case was where a 34.5-in. cylinder was bushed to 33 in., with perfect success.

In this case, the exposed area would have, at 150 lb. pressure, a flat 8-ton thrust, had not the heads butted.

The third and last case was a 30.5-in. reduced to 29 in. Just a strong eighth of an inch was left exposed and that gave 140 lb. of steam the chance it was looking for.

There was a thrust of only 6.5 tons at every stroke but it worked the brass screws loose and the bushing rammed the heads not less than 10 times before steam was shut off.



Cylinder Head Prevents Liner Movement

It did two things. It made a 6-hr. job for two or three mechanics (disconnecting and re-connecting the rod and valve-gear, beside re-fastening the bushing, it being a twin engine), and started a good engineer's hair toward greyness.

From the foregoing, it would look as if exposed areas in cylinder liners or bushings, were things to avoid when possible.

New York, N. Y. C. W. PETERS.

Piston Rod Breakage

Q. Why should a piston rod break flush with the piston? Is not the theory of crystallization of the metal in such cases incorrect? R. B. F.

A. Apparently this question is purely a theoretical one inasmuch as we have been informed by an engine manufacturer that they have no knowledge of piston rods having broken in the particular place mentioned.

Stress concentration caused by the shoulder might possibly be blamed for such a failure, although in Strength of Materials (D. Van Nostrand) Timoshenko says:

"In discussing the stress concentration produced by sharp variation in the cross sections of bars it was indicated that such stress concentration is especially damaging in the case of varying stresses. Endurance tests made with specimens having abrupt changes of section showed that there was a reduction in the strength due to stress concentration, but this reduction was usually found much smaller than would be expected from the magnitude of the calculated factor of stress concentration. This reduction in strength is especially small in the case of ductile materials. For instance, by testing flat steel plates with circular holes in alternating tensile stress Haigh and Wilson found that the reduction in strength due to stress concentration is small as compared with the calculated effect. This discrepancy is usually explained by the fact that, due to plastic flow, the actual stress at the place of high stress concentration is much smaller than the calculated stress."

In the light of further investigation more definite knowledge regarding the nature of fractures, crystallization is no longer looked upon as a cause of failure, in fact, the term crystallization is apparently a misnomer. Timoshenko says, regarding this type of failure:

"Although a great amount of data concerning strength in fatigue has been accumulated, up to now no fundamental theory has been established to explain the cause and the mechanism of the phenomena. A fatigue fracture was formerly attributed to "crystallation" of the metal, making it brittle. Such a theory was advanced on the basis of the appearance of the fracture. There is a great difference between the fractures of mild steel specimens tested statically and by alternating stresses.

"In the first case a considerable plastic flow precedes fracture and the surfaces at the ruptured section show a silky, fibrous structure due to the great stretching of the crystals. A fatigue crack however looks entirely different. A crack starts at a certain place, due to a local defect in the material, or due to stress concentration produced by an abrupt change in the cross section. Once formed, it spreads due to stress concentration at its ends under the action of alternating stresses and this spreading progresses until the cross section becomes so reduced that the remaining portion fractures suddenly under the load.

"Two zones can usually be distinguished in a fatigue fracture, one due to the gradual development of a crack and the other due to sudden fracture. The latter resembles the fracture of a tensile test specimen with a narrow deep groove in which the form prevents sliding and fracture occurs as a result of overcoming the cohesive forces; this fracture is of the brittle type, such as occurs in cast iron, even if the material is ductile. In the case of cantilever test specimens the maximum stresses are at the outlet fibers; the fatigue crack is usually started at the circumference and spreads toward the center.

"Where there is stress concentration due to fillets, grooves or holes, the crack usually starts at the most highly stressed portion and spreads from this point as a center and fracture reveals concentric rings with respect to this starting point. This is a very familiar type of fracture in machine parts which have been submitted to alternating stresses. It is thus evident that the brittle type of a fatigue fracture is due to the peculiar mechanism of fracture and not to 'crystallization.' We now know that the individual crystals remain unchanged during an endurance test except that there may be some 'slipping' within these crystals."

If any of the readers of Power Plant Engineering have had trouble regarding piston rod failure at the point mentioned we would appreciate hearing of their experiences.

Correction Note—As One Engineer to Another

ATTENTION has been called to errors appearing in the article, "As One Engineer to Another," in the June 1935 issue, page 353. In the third paragraph, "3000 lb." should have been 3000 gal. of product, as worked out in the solution. In the problem, paragraph 7, however, the weight of a gallon of water is omitted, the equation should read:

$H = 3000 \times 0.8 \times 8.33 \times 0.65 \times 140 = 1{,}819{,}272$ B.t.u.

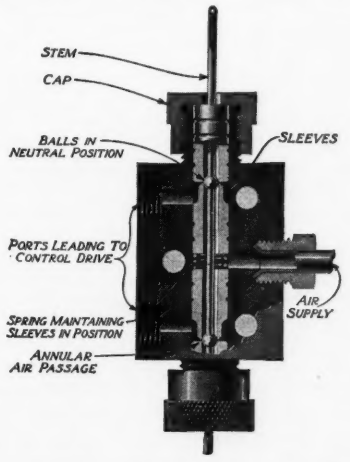
In the second column of the same page, 20th line, "0.75V is W" should be "0.075V is W," and the 15th line from the bottom should be V = 1,388.9 cu. ft. instead of 13,889 cu. ft.

New Equipment

New Combustion Control

AIR OPERATED COMBUSTION CONTROL which automatically operates boilers to maintain steam pressure, furnace draft and combustion economy has been developed by Bailey Meter Co., Cleveland, O. To accomplish this, the demand for steam is measured by variations in steam pressure and the rate of combustion is varied accordingly by the simultaneous control of fuel and air utilizing the steam flow—air flow relation of the Bailey boiler meter to readjust fuel or air supply so as to continuously maintain maximum combustion economy.

The control system is based upon the measurement of factors involved by standard Bailey recorders in which are incorporated frictionless free floating air pilot valves. As will be noted from the illustration, these pilot valves are constructed so that they in no way decrease the accuracy or limit the operating ranges of the devices by which they are actuated. Air is admitted at constant pressure to the space between the two balls. Since the balls are of equal size, this results in a perfectly balanced valve. Being of slightly smaller diameter than the pilot valve sleeve, a small quantity of air escapes which tends to prevent actual contact between the balls and the sleeve and acts as an effective lubricant.



The pilot valve shown is used for operating control drives. Two outlets are connected to the control drive cylinder so that when the pilot valve is in a neutral position the air pressure supplied to each side of the piston produces equal opposing forces and, therefore, the piston remains stationary. Should the pilot be moved slightly in either direction, increased air pressure would be admitted through one port to one side of the piston and air would be exhausted from the other side through one other port.

Complete flexibility of the control system is provided by selector valves on the master and individual boiler panels. These selector valves provide for complete or partial automatic control, manual control and boiler load adjustment. The position of equipment under control is indicated by a pointer and dial on the selector valve.

New Mixture Removes Paint from Surfaces

A NEW METHOD of removing paint from transformers or other equipment has been developed by Oakite Products, Inc., of New York City. This method employs Oakite Cold-strip, a liquid which is said to effect the quick removal of paint from metal surfaces. It is simply sprayed on and then rinsed off. No heat is required and there are said to be no fumes. Applied with a special spray gun this product provides an economical, speedy method for stripping paint and makes it a simple, easy, practical two-man operation. Several coats of paint it is claimed are usually removed with the first application but where there are 10, 20 and 30 coats of paint and it is necessary to strip down to the metal surface additional applications are necessary. Two gallons of the mixture covers an area of 100 sq. ft. in 1½ minutes.

Brushes for Heavy Duty D. C. Power Service

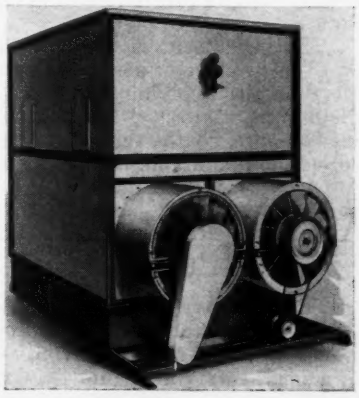
MANUFACTURERS AND users of heavy duty direct current generators, motors and rotary converters will be interested in the announcement by the Carbon Sales Division of National Carbon Company, Cleveland, Ohio, of a new series of electrographitic brushes designed especially for service on heavy duty direct current equipment.

This new series of brushes is the product of a 4-yr. program of research applied to the problem of determining the fundamental physical properties essential to satisfactory brush performance on heavy duty direct current equipment, the combinations of materials possessing these necessary properties, and exact methods of production control to insure uniformity in both product and performance.

The new series of brushes resulting from this program are to be known as the "SA" Series of National Pyramid Brushes. The series consists of 5 grades, namely, SA-25, SA-30, SA-35, SA-40, and SA-45.

Indoor Cooling Towers

THE BINKS MANUFACTURING CO., 3114-40 Carroll Ave., Chicago, Ill., has recently placed on the market a complete line of indoor forced



draft cooling towers. Eight sizes are available, ranging in capacity from 5 to 150 g.p.m. circulation, for the cooling of condensing and circulating water for refrigeration and industrial processes. The tower housing is constructed of a heavy gauge galvanized copper bearing steel and the fan of aluminum alloy. Warm water is delivered to the tower from the condenser or other process to a system of Binks Rotojet clog-proof nozzles. The two small sizes, i.e., 5 and 10 g.p.m. capacity are furnished as a complete self-contained unit, and the larger sizes made up in sections which are conveniently assembled on the job. All sizes of towers are furnished complete with fan and fan motor, together with water circulating pump where desired. All sizes of towers can be arranged for automatic operation where necessary.

Taylor Intermitter

A NEW CONTROL INSTRUMENT for the automatic, intermittent operation of diaphragm valves or other diaphragm-operated devices is announced by the Taylor Instrument Cos., Rochester, N. Y. The intermitter differs in function from the time-cycle controller in that it is limited to the repetition of a single operation whereas the latter is capable of performing a number of different operations during the revolution of the cam.

The simplicity of design and small number of moving parts is obvious from the accompanying illustration. Instead of employing the conventional fixed cam to time the intermittent operation of a diaphragm valve or other diaphragm-operated devices, the Taylor Intermitter has a circular cam on which the proper number of actuating lugs may be placed; the number of lugs corresponding with the number of operations to be performed during the rotation of the cam. As many as twenty lugs may be used.

The instrument is available in two types: Reverse-acting; lugs to close nozzle, applying pressure to diaphragm motor. Direct-acting; lugs to open nozzle, relieving pressure from diaphragm motor.

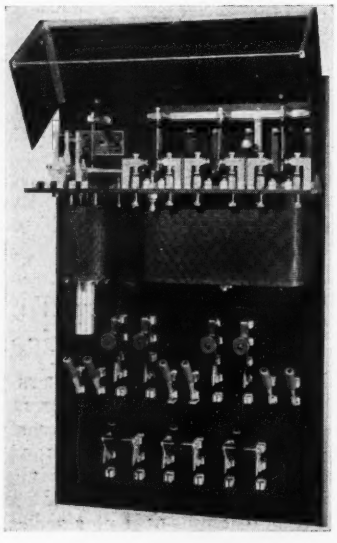
Air Driven Centrifugal Pump

THE PNEUMATIC SPONGE recently developed by the Byron Jackson Pump Co., Berkeley, Cal., consists of a small rotary air motor driving a centrifugal pump with a capacity of about 75 g.p.m. against a total head of 125 ft. Compressed air at from 70 to 110 lb. is used as the motive power. Particularly designed to handle water containing quantities of sand and abrasive, the runner is of the two ported, nonclogging type and the complete unit weighs only 85 lb., its maximum width is 12¼ in. and height about 26 in.

Simple Voltage Regulator

THE SIMPLEX CORPORATION of Burlington, Iowa is marketing a new type of voltage regulator for the maintenance of close voltage regulation in a. c. generator installations. It is of the vibrating contact type and embodies all advantages inherent with this type.

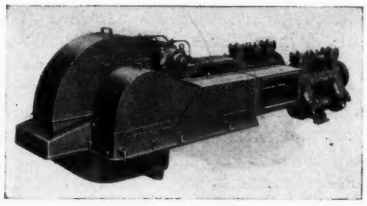
It is, however, greatly simplified in construction, having no dashpots or other damping or retarding devices. Delicate mechanisms and complicated circuits have been avoided. The main coil is actuated by alternating current only. The main contacts are made of platinum and iridium and the relay contacts of tungsten or silver. The design is such as to maintain a very close voltage regulation over the entire load range and at the same time give quicker response to load changes than regulators hitherto on the market. The regulators are arranged for operation with one or more generator operating separately or in parallel. The regulators are suitable for use in connection with a. c. generating units of capacities from 1 up to 5000 kw.



These regulators are now in use in many prominent plants. The construction is covered by patents recently granted.

Fully Enclosed Power Pump End

WORTHINGTON Pump & Mach. Corp., Harrison, N. J., announces the completion of an 18-in. stroke totally-enclosed horizontal duplex power pump for a wide range of services. The power end is self-



contained and supported on the foundation throughout its length to minimize the cost of foundations. The complete pump may easily be set up without danger of misalignment. An oil pump, driven by a crank from the pinion shaft, supplies oil for the flood lubrication of all bearings and the pressure spray lubrication at the intermesh of the gear and pinion. The main gear and pinion are full herringbone and may be of any ratio required up to 9.66 to 1.

Two New Network Cables

TWO NEW NETWORK cables, one a leaded-type cable for use in ducts and the other a non-metallic cable for 600 v. service, have been made available by the General Electric Company.

In the leaded-type cable, a layer of Glyptal treated cloth covers the conductor and two layers of asbestos cover the Glyptal cloth. Both the cloth and the asbestos are treated with Pyranol and the whole is enclosed in a lead sheath.

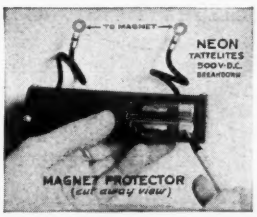
The new leaded-type cable is the first in which the unusual mechanical and electrical properties of both Glyptal cloth insulation and Pyranol have been brought together to provide a network cable that is absolutely flameproof and whose insulation will not give off explosive gases.

The new non-metallic cable for 600 v. service features a Glyptal compound sheath and a rubber compound insulation which is

highly moisture-resistant. The properties of the Glyptal sheath make this cable suitable for use in oily or alkaline locations where protection against abrasion is not necessary; and because of the extremely low water-absorption factor of the rubber compound used for the insulation—which does not exceed 0.015 gram per inch—the new cable can be used in ducts or buried directly in the ground. When furnished with a treated-braid reenforcement, it can be used as a portable cable.

New Device Protects Against Over Voltage

Littelfuse Laboratories, Chicago, Ill., have placed on the market a new magnet and coil protector, using thin new neon Tattelite (potential fuses)—an electronic device. The new Magnet Protector Tattelite is designed to prevent insulation breakdowns in direct current magnets, solenoids, shunt and compound wound motors, and gen-



erators, coils, etc., due to the high voltage self-induced surges, which occur when the circuit is suddenly opened. Even in 110 volt service, 10,000 v. surges are not uncommon. The Protector Tattelite is connected across the equipment to be protected. Its characteristics are such that no current flows until the voltage reaches a dangerous value; it then suddenly conducts and shunts out the surge.

THE VIBRATION ELIMINATOR, a new shock absorber or cushion for machinery, has just been introduced by the Vibration Eliminator Co., 41-26 37th Street, Long Island City, New York. This new device consists chiefly of a base stamping and supporting housing to which the leg or base of the machine may be rigidly fastened. The Vibration Eliminator relies for its efficiency chiefly upon a new table of selected loadings on pure natural cork which has for many years been considered by engineers as the foremost isolating material.

Ideal Combination Cleaner

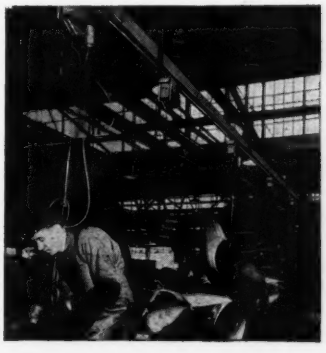
FOR INDUSTRIAL vacuum cleaning, blowing and spraying, a combination portable cleaner is now being built by the Ideal Commutator Dresser Co., 1555 Park Ave., Sycamore, Illinois.

When used as a vacuum cleaner, the accumulations of dirt, dust and scrap, are first drawn into a 12-gal. aluminum finished steel tank, where the heavy dirts, metals, filings and turnings are deposited and only the very fine dusts and dirt are drawn into the dust-proof bag. This design prevents the heavy materials from passing through the fan and injuring the fan blades. As collections in the metal tank can be easily salvaged. this machine is being used more and more in shops and plants where work in expensive and precious metals is done.

The removable type motor unit allows for quick and easy change-over from vacuum cleaning to blowing. It has a universal 1-hp. motor and a 7-in. fan, which creates a vacuum of 46½ in. waterlift. When used as a blower, it delivers a stream of dry air at the nozzle of 25,200 ft. per min.

Trolley System for Electric Tools

A SYSTEM for providing mobile electric circuits for portable tools so that work can be followed along conveyor and assembly lines without the use of long, unwieldy and dangerous cords and cables, has been introduced by the Switch & Panel Division, Square D Company, Detroit, Mich. The system is known as Trolley SQUARE-Duct and consists of an almost entirely closed duct containing stationary buses, along which travels a carriage or trolley. Collector wheels



of the trolley transmit the current by means of wire connectors to the tools.

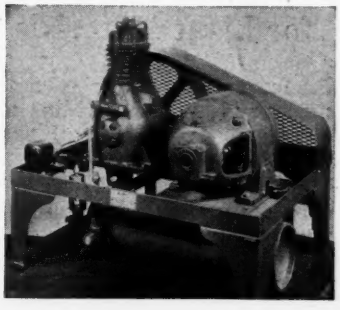
One type of duct section has a "gate" which can be pushed back, permitting the removal or insertion of a trolley. Curved sections are also manufactured to meet building or manufacturing requirements. Feeders or sub-feeders can be brought into the system at any point by means of special connection boxes, which do not interfere with the operation of the trolleys.

The duct is quite rigid and of exceptional strength. Any number of trolleys can be operated on the system, the duct supporting at least five trolleys per 10-ft. section, with tools.

Other applications include supplying current to small traveling hoists, feeding motors of machines on which the motors are mounted on a traveling bed, for portable tools used in various parts of a building or department and wherever long electric cords or cables form an inconvenience or a hazard.

New Refrigerating Units

TO MEET EXACTING NEEDS, a new line of open type commercial condensing units, available in three suction-pressure ranges, is announced by Westinghouse Electric & Manufacturing Co. The new units are divided into Low, Standard and High suction-pressure classifications, as designated by the



last letter in the model number, L–Low, S–Standard, and H–High. The low suction pressure range extends from 31 deg. below to 5 deg. above zero; the standard suction pressure range is from 13.5 deg. below to 20 deg. above zero, while the high suction pressure range is from 10.5 deg. to 40 deg. above zero. This range of suction pressures may be had in all 1 and 1½ hp. models and Standard and High suction ranges are obtainable in 2 and 3 hp. models.

Non-Corrosive Castings

NEW DEVELOPMENTS in corrosion-resistant castings by the Bayonne Foundry of The International Nickel Co. has been announced in connection with the production of a new material to meet special purposes. Known as S Monel, this material is somewhat similar in analysis to regular Monel metal, the essential difference being in silicon content, which is raised to a maximum of 3.75 per cent. In properties it has a higher hardness than the regular grade of Monel metal and greater resistance to wear and erosion, particularly steam erosion, and it is non-galling, especially at high temperatures. As cast, the material can be machined without difficulty if the hardness is held to 325 Brinell by limiting the silicon to 3 per cent. The harder grades must be softened for machining and later re-hardened by heat treatment. In pounds per square inch the tensile strength ranges from 100,000 to 120,000 and the yield point about 10,000 lower. Elongation and reduction of area is from 2 to 5 per cent and the Brinell Hardness from 275 to 350. Another grade of Monel metal, developed coincidentally, has an intermediate hardness of about 225 to 250 Brinell. Its chief advantage is a higher ductility than S though it is not as outstanding in antigalling qualities. Its silicon content is approximately 2.50 per cent.

New 100 Ampere Welder for Light Materials

A NEW, SMALL, low priced motor generator type of arc welding machine is announced by The Lincoln Electric Co. This machine brings the many advantages of arc welding to automobile repair shops, sheet metal and fabricating shops and others called upon to weld thin gage materials.

Known as the SA-100, this new unit delivers as low as 30 amp. at the arc without use of auxiliary devices. It is of the motor driven type, with a current range of 30 to 125 amp. The generator is of single operator variable voltage type with 100 amp. NEMA rating. Easy welding is assured by patented dual control which provides independent adjustment of open circuit voltage and welding current.

The motor installed is the Lincoln "Linc-Weld" 5 hp. squirrel cage induction type for across the line starting. The starter switch is of push button type. Wing nut cable terminals permit easy change of welding current polarity. The new welder is normally 220 or 440 v. and can be furnished for 110 or 550 v., 3 or 2 phase, 60 or 50 cycles as desired. Connections are readily available for reconnecting from 220 to 440 v., or vice versa.

The unit is 20 in. long, 16 in. wide and 40 in. high. It requires less than 2¼ sq. ft. of floor space.

Light-Weight Refractory Concrete

NEW TYPE of Firecrete for casting light-weight refractory concrete on the job has just been announced by Johns-Manville. Known as L. W. (or Light-Weight) Firecrete, this new product is composed chiefly of high alumina clay calcined at high temperatures, the resulting concrete weighing only 75 lb. per cu. ft. Under continuous operation at 2400 deg. F., shrinkage is said to be practically negligible, without spalling under severe tests.

Since L. W. Firecrete is light and has low heat storage capacity, intermittent furnaces can be brought up to temperature in a short time with small waste of heat each time the furnace cools, and, as thermal conductivity is low, radiation losses are small.

For furnace doors and floors, it is stated that the material can be put in service after 12 to 24 hr. air-curing.

ELECTRIC SWIVEL COMPANY, Buffalo, N. Y., have recently placed on the market a new swivel plug. The idea of this plug is to prevent cords from twisting. Instead of the kink being taken in the wire it will be taken out at the plug. It is adaptable to electric drills, soldering irons, extension cords, or any other electrical device in which the cord is subject to twist.

New Diesel Generator Set Introduced

JOINT ANNOUNCEMENT is made by the Harnischfeger Corp. of Milwaukee, and the Caterpillar Tractor Co. of Peoria, Ill., of a coöperative arrangement for building Diesel powered generator sets which will bear the name plate, "Harnischfeger-Caterpillar."

Offered in capacities ranging from 35 to 60 kw., these sets fill all a.c. and d.c. requirements. Generators are of the single bearing type directly connected by link coupling to the Diesel engine and mounted on a substantial cast iron base.

Standard unit will include the engine with all auxiliaries, radiator cooling system, starting engine, auxiliary fuel pump, engine controls to provide proper speed setting and close governing, coupling between engine and generator, flywheel and coupling guard and the generator mounted on the unit base.

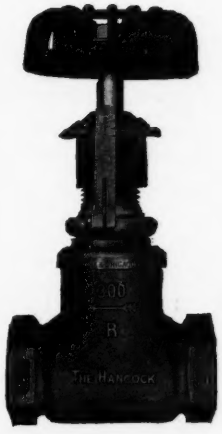
Refrigerating Units

EXTENSION of its line of Freon Balanseal condensing units from 7½ to 25 hp. is announced by the York Ice Machinery Corp., York, Pa., increasing the number of machines in this series to 18. At the same time, three new horizontal type air conditioners, in capacities up to 30 t. of refrigeration, are being introduced as related equipment. The new models are shipped complete with motor, compressor, receiver and automatic controls all mounted on one base. Water valves of ample size, vee belts, a belt adjustment, high pressure cut-out, low pressure control, liquid line strainer, and a suction strainer are standard equipment.

NOTABLE as an example of construction of pressure vessels by welding is the 3600 cu. ft. tank for propane gas at 200 lb. pressure constructed of high carbon steel, 2 in. and under in thickness. All seams were butt welded by the shielded arc process of Lincoln Elec. Co. of Cleveland, fabrication being done by Biggs Boiler Works Co. of Akron, Ohio, to pass hydrostatic and hammer test for 400 lb. pressure according to requirements of the A. S. M. E. code for unfired welded pressure vessels. The tank is 67 ft. long, 8 ft. 10 in. diameter and contains 41 t. of steel.

Flow Control Valve

HANCOCK VALVE DIVISION of the Consolidated Ashcroft Hancock Company, Bridgeport, Conn., recently announced the Hancock Flocontrol Valve. This valve is made with a micrometer and a special slotted valve seat so that the flow through the valve is directly proportional to the number of turns of the hand wheel. With the micrometer adjustment the valve can be regulated to within one-tenth of a turn and each increment of the



valve opening in tenths of a turn will vary the flow proportionately. That is, if the valve is set at two turns open, twice as much steam or liquid will flow through as when it is set at one turn. This valve is built with bronze body for pressures up to 300 lb., in either globe or angle type, in sizes from 3/8 to 2 in., and is suitable for the control of either steam or liquids.

New Shovels Announced by Link-Belt

ANNOUNCEMENT is made by Link-Belt Co., Chicago, of the perfection and the placing on the market of two new models of crawler-mounted shovels, cranes, draglines to be known as models K-40 and K-45 respectively. It is stated that while the basic design is similar to that of the two models that are discontinued, the new machines embody other features which assure their attaining the maximum in ease of operation and maintenance, in performance and in service life.

REPUBLIC DOUBLE STRENGTH STEEL is a new high tensile steel product of Republic Steel Corp., Youngstown, Ohio. The new steel is a copper-nickel-molybdenum ferrous alloy with yield point and tensile strength sufficiently higher than ordinary carbon steel to permit the use of 30 to 40 per cent lighter sections without sacrifice of strength or safety factor. Good corrosion-resistance and forming qualities make Republic Double Strength Steel particularly well suited for the construction of railroad, truck and bus transportation equipment.

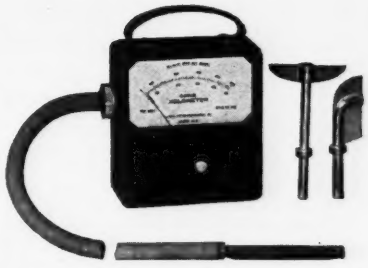
Republic Double Strength Steel is made in two carbon ranges and is available in the usual commercial forms. It can be arc, gas or spot welded without loss of ductility at or adjacent to the weld. Cold forming tests have shown the superiority of this alloy from the standpoint of ductility over similar products with the same physical properties.

Air Velocity Meter

THE BOYLE VELOMETER, offered by the Illinois Testing Laboratories, Inc., 141 W. Austin Ave., Chicago, Ill., is a direct reading air velocity meter which gives accurate and instantaneous readings of the speed and direction of air motion measured in feet per minute. It is housed in an attractive black bakelite case 5¼ by 5¾ by 2⅞ in. in size and weighs approximately 2 lb.

Air enters through a port or a jet and tube (depending on the style used) and leaves through a port on the right side of the meter. This air passing through the meter actuates a movement comprising a vane, control springs, pointer, and magnetic damping system. No mathematical calculations or stop watches are necessary to determine the velocity readings. A pointer locking button is provided to lock the pointer to retain the reading or when the instrument is not in use.

The Velometer is furnished in two types each with a standard double range scale of 0-300 and 0-3000 f.p.m., although other ranges are also offered. The low



scale on either type provides accurate readings as low as 20 f.p.m. while the high scale provides accurate readings up to the maximum limit of the scale.

The shutter type is furnished with a shutter for opening or closing the port for changing the range and is not provided for tube attachment. This type is ideal for taking quick commercially accurate readings such as in heating and ventilating and air conditioning work.

The tube type (illustrated) is similar to the shutter type and when used for the low range readings, the tube attachment is removed and the air enters directly through the port. For high range readings a tube attachment with a suitable jet is used. The air enters through this jet. As the tube is flexible the jet can be moved about as required with the instrument held stationary if desired.

With the tube type Velometer, accurate velocity readings of the discharge or suction of grilles, ducts, or other restricted and small openings can be easily and quickly obtained. Special scales and attachments can be built for unusual applications such as high velocities, high temperatures, and similar service.

A NEW 2-quart vaporizing liquid fire extinguisher that is discharged by air pressure and delivers a fan-shaped spray as well as a solid stream has just been announced by the Pyrene Manufacturing Co., Newark, N. J. This extinguisher known as the Pyrene 2-quart Pressure Type is recommended for incipient fires in all classes of material, and especially for flammable liquids and electrical fires. Due to the fact that it is of the pressure type and has a special combination nozzle, it is anticipated that it will be extensively used in factories and around electrical equipment and flammable liquids.

News From the Field

SEVENTH INTERNATIONAL CONGRESS of Refrigeration is to be held at The Hague, Holland, June 16 to 20, 1936. The work of the Congress will be divided into four sections; the Scientific section in which the application of refrigeration for pure'y scientific purposes will be treated; refrigeration machinery and materials; applications of refrigeration in connection with hygiene, medicine, industry, trade and transport; and legislation, education, propaganda, economy and statistics. Professor M. de Haas of The Netherlands Association of Refrigeration and professor in the technical high school at Delft, is president of the Executive Committee. Further information may be obtained from the American Institute of Refrigeration, 433 N. Waller Ave., Chicago, Ill.
Catalog Note

LEE WRIGHT has been appointed sales representative for Republic Steel Corp., with headquarters at 401 Atlas Bldg., Salt Lake City, Utah, according to an announcement by N. J. Clarke, Vice President in Charge of Sales for Republic. The Salt Lake City territory, in the past has been handled through Republic's Denver office.

AT THE ORGANIZATION meeting of the directors of The Superheater Company, held on May 17, 1935, George L. Bourne, Samuel G. Allen, and Frederic A. Schaff were appointed the Executive Committee. Mr. Allen was elected chairman of the Executive Committee. Thomas F. Morris was elected secretary and assistant treasurer of the company.

WORTHINGTON PUMP AND MACHINERY CORP. announces the appointment of J. E. Holveck as special sales engineer, operating from its Pittsburgh office but extending his activities also to the territories of the Cleveland, Detroit, Chicago and Buffalo Offices. Mr. Holveck was formerly a member of the engineering staff of Worthington's Holyoke Works and later was associated with The Aldrich Pump Co. as sales engineer in its Pittsburgh and middle west districts.

THE BURNS & MCDONNELL ENGINEERING CO. has established a permanent engineering office in the Home Savings Bank Building, Albany, New York. This eastern engineering office will be in charge of Hartwell J. Rosson, who was formerly in charge of the Cincinnati office. The Cincinnati office is now in charge of M. C. Bartlett.

THE BUFFALO, N. Y., district sales office of Republic Steel Corp. has been removed from 475 Abbott Road to 1020 Liberty Bank Building. Thos. B. Davies continues in charge of the office as District Sales Manager, assisted by his present staff.

SHEPPARD T. POWELL, Chairman of the Boiler Feed Water Studies Committee of the American Water Works Assn. since its inception ten years ago, has resigned due to the pressure of private engineering practice. Following acceptance of the resignation C. H. Fellows of the Detroit Edison Co., was elected Chairman of the Committee, and C. H. Bardwell of the C. & O. R. R., Vice-Chairman. Mr. Powell continues as a member of the Executive Committee.

AT A RECENT meeting of the Board of Directors of the Morse Chain Co., Ithaca, New York and Detroit, Division of Borg Warner Corp., the following officers were elected: D. B. Perry, President; C. J. Kenerson, Vice President, General Manager and Treasurer; N. K. Van Osdol, Secretary and Assistant General Manager; S. B. Waring, Assistant Secretary and Assistant Treasurer. Frank M. Hawley was appointed Sales Manager of the Automotive Division and Manager of the Detroit Plant.

ELECTION is announced of Albert C. Bruce, President of the United States Hoffman Machinery Corp., to the Board of Directors of the Worthington Pump and Machinery Corp. Mr. Bruce is also a director of the Baltimore National Bank and Central Savings Bank, Baltimore, and likewise a member of the Reorganization Committee of the Symington and Gould Coupler Companies.

AT A RECENT meeting of the Board of Directors of the Combustion Engineering Company, Inc., F. H. Rosencrants was elected a Vice President, effective June 1, 1935. He will assume charge of the Proposition Engineering Department. Mr. Rosencrants for a number of years was mechanical engineer with the Electric Bond and Share Co. and later Chief Engineer of International Combustion, Ltd., of England. In these positions he was responsible for the design of many of the outstanding plants in this country and the British Empire.

GIRTANNER CONVEYORS & ENGINEERING CO., 30 Church St., New York, announces the appointment of Geerlings & Henschel of Milwaukee, Wis., as representative in the state of Wisconsin.

LINK-BELT CO., New York, announces the appointment of Woodward & McMillan, Aptdo. 1691, Edificio Metropolitana, Havana, as its representatives for the sales of its industrial elevating, conveying and power transmitting chains and machinery in Cuba. For 13 yr. prior to the forming of the partnership, Mr. Woodward had been engaged in merchandising in Latin America, including Cuba. Mr. McMillan is a mechanical engineer by profession, and prior to 1926, had spent twenty odd years with Latin American railways.

For the Engineer's Library

THE MUNICIPAL YEAR BOOK, edited by Clarence E. Ridley and Orin F. Nolting. 392 pages, clothbound, published by International City Managers' Assn., 850 E. 58 St., Chicago, Ill., 1935, price $4.00.

This second edition of the Year Book for American cities is much larger than the first edition with more than 100 pages devoted to a resume of significant events and developments in the various fields of municipal administration in 1934. New sections included this year consist of one on local government units, an accurate count of which was made for the first time in 1934; data on the 96 metropolitan districts in the United States; detailed state-by-state discussion of legal classes of cities and forms of city government which may be adopted; activities and services of state municipal leagues; municipal personnel and retirement data; activities of professional organizations of public officials; and services rendered to municipal officials by federal agencies and national organizations of public officials. The book contains a great deal of important data about each of the 960 cities over 10,000 population in the United States, such as population, area, form of government, number and terms of councilmen, election date, number of registered voters, number of votes cast at last councilmanic election, population over 21, and utilities owned and operated.

The financial data given is the most recent information available on receipts, expenditures, and indebtedness of nearly 250 cities over 30,000 population. Receipts are classified according to source, showing amount from property taxes, grants and shares, miscellaneous revenue, borrowing against current revenue; also for schools, utilities, and receipts from proceeds of bond sales. Total accumulated delinquent taxes at the end of the year, and assessed valuations are shown. Expenditures are broken down for welfare and relief, current operation and maintenance, debt service, capital outlays, and repayment of current borrowings; also for schools and utilities, and proceeds from bond sales.

The debt tables show the gross and net bonded debt—general, schools, utilities, and special assessment; also bonds issued in 1934, bonds redeemed in 1934, and total unfunded debt at the end of 1934.

NATIONAL PUBLIC WORKS, Geneva, League of Nations, 1934. 281 pages. Price, $3.00. Available in this country only from the World Peace Foundation, 8 West 40th Street, New York, N. Y.

In the majority of countries throughout the world since 1929 public works programs of greater or less extent have been initiated. From its experience in this line each government has learned certain things, has discovered certain fundamental principles which in a general comparison of programs, would be of inestimable value to other nations faced with similar problems.

Such a comparison has now been made and its results recorded in National Public Works, a recent publication of the League of Nations. This volume is the fruit of a continuous international study of general questions relating to public works, including big programs of works financed out of national resources. In it are reproduced the replies of twenty-nine governments to the request for detailed information on the matter, sent out by the Secretary-General of the League. This inquiry is the first of its sort to be based on official information requested from all governments.

THE A.S.H.V.E. GUIDE 1935, Volume 13, 1000 pages, 6 by 9 in., 41 chapters of technical data, catalog section, indices, roll of membership. Published by the American Society of Heating and Ventilating Engineers, 51 Madison Ave., New York. Price $5.00.

Greatly enlarged to include the results of the latest research in heating and ventilating theory and practice, the 1935 Guide has been made even more useful to engineers than its predecessors. The features of particular appeal in this volume are: the new technical data, the carefully prepared and enlarged index, and the new department devoted to problems in practice. Special consideration has been given to air conditioning, piping and fittings which are subjects of particularly live interest. This Guide contains a new psychrometric chart, heat transmission tables have been extended and many new illustrations are used to give completeness to the text.

AMERICAN DISTRICT STEAM CO., North Tonawanda, N. Y., has just issued its bulletin No. 35-75 on Adsco storage water heaters, giving not only information on the design and construction of the heater itself but other useful engineering data which are of aid to the engineer in estimating hot water demands.

STANDARD OIL CO. of Indiana, 910 S. Michigan Ave., Chicago, is publishing a series of industrial lubrication monographs which deal with specific problems in various industrial fields. These bulletins are prepared by the engineering department and are of aid to the man in charge of lubrication. Three of the most recent bulletins are entitled: The Lubrication Engineer—His Value to You; The Lubrication of Diesel Air Compressors, and Diesel Engine Bearing Lubrication.

THREE BULLETINS of interest to engineers were recently issued by the Scovill Mfg. Co., Waterbury, Conn. One deals with condenser tubes and covers the various alloys from which they are made, the manufacturing methods, installation methods and ferrule specifications. The second is a price list of ferrules and the third is a story of Scovill, giving the history of the company, showing the products they manufacture and the materials from which they are made and a short reference to the company's divisions and subsidiaries; the Oakville Division, Waterbury, Conn.; the Plumbers' Brass Goods Division, Waterville, Conn.; the Morency-Van Buren Division, Sturgis, Mich.; the A. Schrader's Son, Inc., Brooklyn, N. Y., and the Hamilton Beach Mfg. Co., Racine, Wis.

AMERICAN PULVERIZER CO., 1249 Macklind Ave., St. Louis, Mo., has just issued a new catalog illustrating and describing the American Crushers and Pulverizers for laboratory use.

BEAVER PIPE TOOLS, INC., Warren, Ohio, is distributing some new literature dealing with the latest developments in Beaver pipe threading and cutting tools, among which is the Model A which is a portable pipe and bolt threading machine especially useful in power plants.

THE LOUIS ALLIS CO., Milwaukee, Wis., has recently published its bulletin No. 601 dealing with the special characteristics and containing other important information regarding electric motors for centrifugals.

AS A COMPANION BOOK to GEA-1731, "How to Make Cable Joints," issued last year, the General Electric Company now has available a new publication, GEA-1839, "Cable Accessories." The two books should be of interest and assistance to everyone who is engaged in work that involves the jointing and terminating of insulated cable.

"Cable Accessories" lists and describes all the materials required for this work—joints, connectors, terminals, reservoirs, and other materials. It has eighty pages and is complete in every respect—including prices. It should prove useful in making up jointing standards and as a general reference book.

THE LEONARD CIRCUIT TESTER is described in a new leaflet just issued by The Leonard Electric Mfg. Co. of Cleveland, Ohio. This new tester known as Model No. 3-DA is a portable type volt-ampere meter combination for both direct and alternating current readings. It requires no external shunts or multipliers and reads direct—no calculations. It is adapted to measure currents and voltages in circuits from ½ kw. to 100 hp.—up to 250 amp. a.c., or 300 amp. d.c. and 600 v. either a.c. or d.c. The whole set is enclosed in a neat, sturdy welded steel case, and weighs complete, 27 lb.

BROWN INSTRUMENT CO., Wayne & Roberts Aves., Philadelphia, Pa., has just issued a folder entitled Hundreds of Dollars Saved by Analyzing Chart Records. This illustrates and describes the company's graphic recording instruments which are used extensively in power plants for the keeping of records.

MERCURY ARC POWER Rectifiers are described in Bulletin 1169 issued by Allis-Chalmers Mfg. Co., Milwaukee, Wis. Bulletin 1171 also issued by the same company describes their Direct Current Generators.

THERM-O-TILE underground steam conduit system is illustrated and described in a booklet just published by H. W. Porter & Co., 825 Frelinghuysen Ave., Newark, N. J. Thermo-O-Tile is a complete conduit system for the permanent protection, support and insulation of underground pipe lines—hot or cold.

ILLINOIS TESTING LABORATORIES, Inc., 420 No. La Salle St., Chicago, has recently issued its bulletin No. 2129 which illustrates and describes a new horizontal edgewise pyrometer which may be furnished either with or without multi-point switch.

GRATON & KNIGHT CO. of Worcester, Mass., in a new publication presents a complete economic study of the application of power to the work. This discusses the economics of the two generally used systems—individual motor and modern group drive. From this discussion, the story is carried on to show the importance of the selection of the proper belt to give the best efficiency to the correct drive. The last few pages contain charts and tables that are useful in figuring the power transmission requirements of any particular machine.

TYPE SSU PUMPING UNITS, single suction, single stage pumps with a squirrel cage motor designed as a compact unit are covered by Leaflet No. 2199 issued by Allis-Chalmers Mfg. Co., Milwaukee, Wis.

More Power for Fords

DIAPHRAGM ASSEMBLY being checked in the top half of the low-pressure steam-turbine casing and exhaust hood of the second 110,000-kw. turbine for the power station of the River Rouge plant of the Ford Motor Co. now being constructed in the Schenectady works of the General Electric Co.

The new unit is similar to the one placed in service in 1930 but operates at a higher temperature. It will use steam at 1200 lb. pressure and 900 deg. F. It is an 1800 r.p.m. vertical compound unit, with the high-pressure turbine and generator mounted directly on top of the low pressure turbine and generator. Each element has a capacity of 55,000 kw.

Power Plant Construction News

Calif., Lodi—City Council, Lodi, plans early special election to approve bonds for $600,000, fund to be used for new municipal hydroelectric generating plant on Mokelumne River and transmission line to city, with power substation and distribution facilites. Financing will be arranged through Federal aid.

Calif., Los Angeles—Metropolitan Water District, 306 West Third Street, has concluded Federal financing in amount of $36,000,000, portion of fund to be used for construction of new 237-mile steel tower transmission line from Boulder Dam hydroelectric power plant to group of new electric-operated pumping stations, to be constructed at same time. Five large pumping plants will be built, each plant to be equipped with three main pumping units. Proposed to proceed with project soon. Engineering department is in charge.

Ga., Glennville—Glennville Ice Co., is considering early rebuilding of portion of ice-manufacturing plant, recently destroyed by fire. Loss close to $50,000, with equipment. W. G. McCurty is general manager.

Ga., Savannah—City Council plans new cold storage and refrigerating plant in connection with new municipal abattoir. Entire project will cost close to $250,000, with equipment. Menges-Mange, Inc., 1515 North Grand Street, St. Louis, Mo., is engineer.

Ill., Chicago—Cromwell Paper Co., 4801 South Whipple Street, plans installation of electric power equipment in new one-story plant addition, 100x270 ft., for which building permit has been issued. Cost about $80,000. A. Epstein, 2001 West Pershing Road, is architect and engineer.

Ill., Ottawa — Libbey-Owens-Ford Glass Co., Nicholas Building, Toledo, Ohio, plans installation of electric power equipment in connection with expansion in laminated safety glass manufacturing plant at Ottawa. Entire project will cost close to $1,000,000. Company engineering department is in charge.

Ind., Kokomo—Kingston Products Co., North Webster Street, plans installation of electric power equipment in new one-story addition to automotive manufacturing plant, 130x270 ft. Cost close to $100,000, with machinery. Work on superstructure will proceed at early date. Oscar Cook, 1420 West Sycamore Street, is architect.

Iowa, Mason City—Hutchison Ice Cream Co., plans installation of power equipment, ice-making and refrigerating machinery, and other mechanical equipment in new plant addition. Cost about $80,000. Work will be placed under way at once. J. A. Johnson is general manager.

Kan., Hoisington—City Council has plans maturing for new municipal electric light and power plant, including electrical distribution system. Proposed to begin work in near future. A bond issue of $150,000 has been authorized for project. W. B. Rollins & Co., Railway Exchange Building, Kansas City, Mo., are consulting engineers.

Ky., Ludlow — Pattison Brothers Kentucky Bourbon Distillery Co., 133 Park Place, Covington, Ky., plans installation of electric power equipment in proposed new distilling plant at Ludlow, where site is being secured. A one-story power house is proposed. Entire project will cost close to $100,000.

Ky., Morehead—Board of Directors, Morehead State Teachers College, will soon take bids for new steam power house at institution, including central heating system. New water system facilities will also be installed. Entire project will cost about $250,000. Joseph & Joseph, Breslin Building, Louisville, Ky., are architects.

Me., Bangor—Department of Public Institutions, State House, Augusta, Me., plans extensions and improvements in steam power plant used for central heating service at state hospital, Bangor. Cost about $40,000, with equipment. Fels Co., 42 Union Street, Portland, Me., is consulting engineer.

Md., Fairview—Rodgers & Townsend, John B. Rodgers, head, operating at yard of Redman-Vane Shipbuilding Co., Key Highway, foot of Warren Street, Baltimore, Md., plans installation of electric power equipment in new shipbuilding and repair plant on 5 acre tract of land on Rock Creek, Fairview, where site has been leased; hoisting, conveying and other equipment will also be installed. Entire project will cost over $65,000.

Mass., Holyoke—Dreikorn Bakery, Inc., 320 Park Street, plans installation of ovens, conveyors and steam power equipment in new addition to plant, including alterations and improvements in present bakery. Cost about $50,000.

Mich., Plymouth—Daisy Mfg. Co., manufacturer of air rifles, liquid pistols, etc., plans installation of electric power equipment in new three-story plant addition. Cost about $50,000, with machinery. Smith, Hinchman & Grylls, Marquette Building, Detroit, Mich., are architects and engineers.

Mich., Pontiac—Fisher Body Corporation, General Motors Building, Detroit, Mich., a subsidiary of General Motors Corporation, same address, plans installation of electric power equipment in new one-story plant addition to automobile body works at Pontiac, 100x350 ft. Cost over $100,000, including machinery.

Mo., Kansas City—Harding Cream Co., 2327 West Penway, plans installation of electric power equipment in new one-story creamery and milk products plant at Nineteenth Street and Forest Avenue. Cost about $80,000, including machinery. Charles A. Smith, Finance Building, is architect. L. P. McCoun is general manager.

Neb., Omaha—Metropolitan Utilities District, Eighteenth and Harney Streets, plans installation of new electric-operated pumping machinery at waterworks station at Florence, capacity about 30,000,000 gal. per day. Cost close to $35,000. Financing is being arranged and bids will be asked closely following.

N. Y., Horseheads—Village Council, Horseheads, has preliminary plans under way for new municipal electric light and power plant. Cost reported close to $125,000, with distribution facilities. H. E. Childs, Sayre, Pa., is consulting engineer.

Ohio, Cleveland — David Archbold, care of Harris Calorific Co., 2828 Washington Avenue, plans installation of electric power equipment in new one-story plant, 100x235 ft., at 5500 Cass Avenue, for manufacture of screw machine products. Superstructure will proceed in July. Entire project will cost about $80,000.

Ohio, Jackson—City Council, Jackson, plans extensions and improvements in municipal electrical distribution system. Cost estimated about $28,000. Proposed to begin work soon.

Ohio, Middletown — American Rolling Mill Co., Middletown, plans installation of electric power equipment in new steel mill, site now being selected. Project will consist of group of buildings with power house, estimated to cost over $2,500,000, with machinery.

Ont., East Windsor—Ford Motor Co., of Canada, Ltd., has authorized new addition to steam-electric power plant for service at local works, comprising three new steam turbo-generator units, 20,000, 5000 and 750 kw. capacity, respectively; new high-pressure boilers, stokers, pumping machinery and complete accessory equipment. Work is scheduled for completion early in 1936. Cost estimated over $1,500,000.

Ore., Portland—United States Engineer Office, Customhouse, will receive bids until July 9 for gantry cranes and steel gates for spillway dam and power house, Bonneville project (Circular 29).

Pa., Coraopolis—Canfield Oil Co., plans installation of power equipment, pumping machinery and other mechanical equipment in connection with proposed rebuilding of oil refining plant, recently damaged by fire with loss of about $200,000.

Pa., New Castle—City Council has authorized ordinance to provide bond issue of $1,500,000 for new municipal electric light and power plant, and electrical distributing system.

Tenn., Dyer—Common Council is considering plans for new municipal electric light and power plant. Cost about $85,000, with equipment. Proposed to arrange bond issue at early date.

Vt., Brandon—Town Council is considering construction of new municipal electric light and power plant. Proposed to secure estimates of cost at early date.

Wash., Okanogan—Okanogan Growers' Union, Okanogan, Vincent Jones, manager, plans new four-story cold storage and refrigerating plant, with capacity for handling 100 cars at one time. Cost over $85,000, with equipment. Proposed to begin work at early date.

Wash., Spokane—Water Department, City Hall, Alexander Lindsay, superintendent, has plans under way for new municipal hydroelectric power station on Spokane River, to be used for power supply for waterworks plant at that location. Installation will include three 1800-hp. propeller type water turbines, direct-connected to three 1625 k-va. generator units. Proposed to ask bids soon. Fund of $687,000 has been arranged, including dam construction.

Wis., Wisconsin Rapids — Consolidated Water Power & Paper Co., plans installation of electric power equipment in new addition to local paper-finishing mill, entire project to cost close to $100,000. W. F. Thiele is chief engineer.